MINISTERIO DE MEDIO AMBIENTE

SECRETARÍA GENERAL PARA LA PREVENCIÓN DE LA CONTAMINACIÓN Y DEL CAMBIO CLIMÁTICO

INM

Hiking accidents and strong northerly winds over Mediterranean Pyrenees

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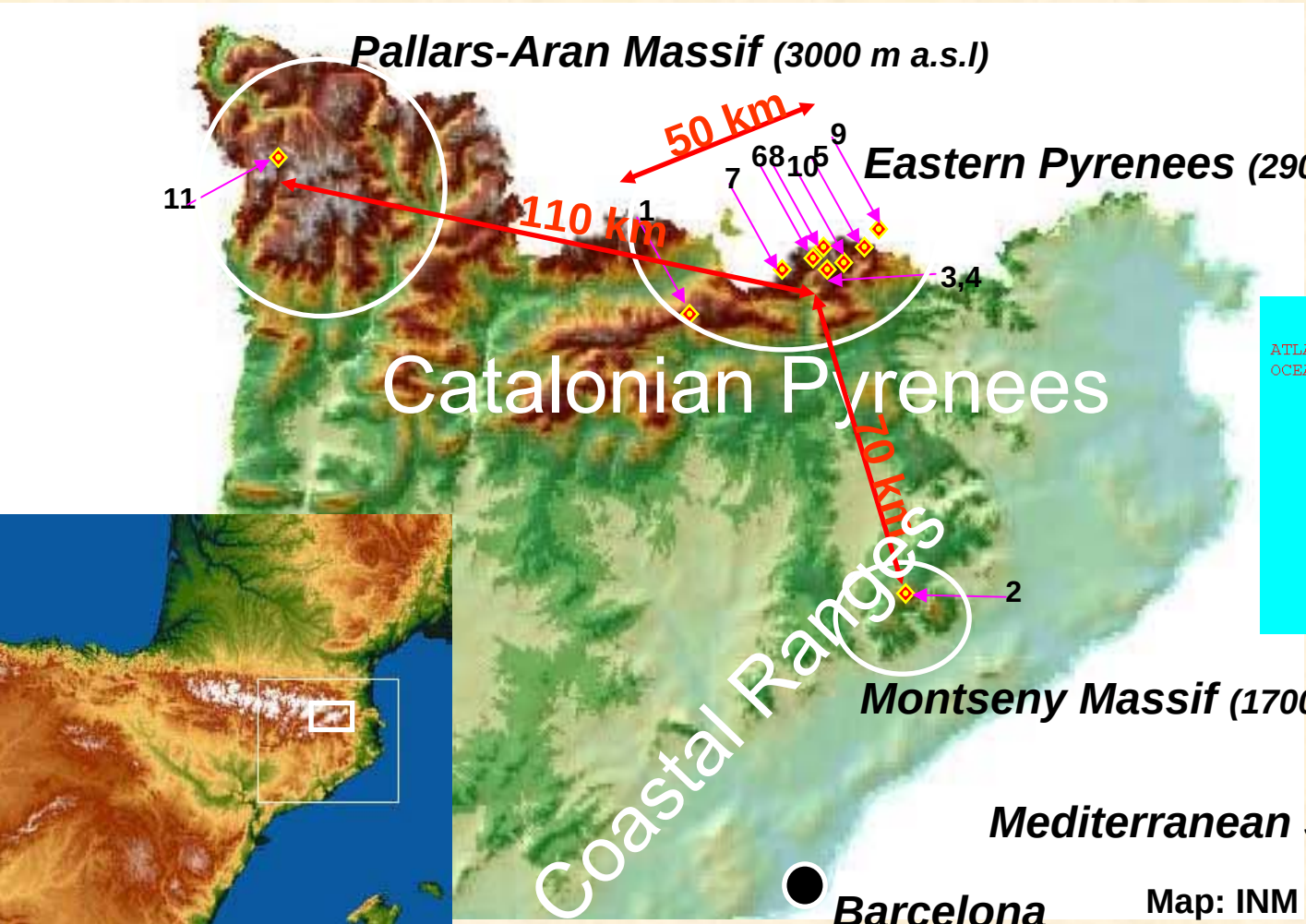
Geographical Features (1)



Cases (1)

In some cases, there is uncertainty in exact date, altitude and location.
Sources: Newspapers, village councils, people's memory, etc.

0) XIX century. *Noucreus* (2800 m a.s.l.). 9 hikers died.
1) 17 February 1930. *Tosa d'Alp* (2000-2200 m). 1 skier died.
2) 6 March 1944. *Matagalls* (1400 m). 2 skiers died.
3) 27/30 December 1968. *Freser Gorge* (1700-2000 m). 3 hikers died.
4) 8 March 1970. *Freser Gorge* (1700-2500 m). 1 hiker died.
5) 26 November 1978. *Costabona* (2200 m). 3 hikers died.
6) 31 December 1979. *Torreneules* (2200-2600 m). 3 hikers died.
7) 4 November 1984. *Puigmal* (2900 m). 1 hiker died. (SW flow)
8) 23 December 1986. *Tirapits* (2700 m). 2 hikers died.
9) 16/17 April 1992. *Canigó (France)* (1500-2700 m). 1 hiker died.
10) 30 December 2000. *Balandrau* (2300 m). 9 hikers and skiers died.
11) 15 February 2005. *Montardo* (2100-2800 m). 1 skier died.

Cases (2)

Geographical distribution

Cases 0, 3, 4, 5, 6, 7, 8, 9, and 10: *Nuria Mountains* (Mediterranean Pyrenees). (9 events). Case 1: *Moixeró Range* (Mediterranean Pyrenees).

Case 11: *Aran Valley*. Central Pyrenees.
Case 2: *Montseny massif*. Coastal Ranges.

Monthly and seasonal distribution

November: 2 cases (5 and 7)
December: 4 cases (3, 6, 8 and 10)
January: 0 cases
February: 2 cases (1 and 11)
March: 2 cases (2 and 4)
April: 1 case (9)

Autumn: 2 cases.
Winter: 8 cases.
Spring: 1 case.

Unknown: 1 case.

Cases (3)

Geographical and seasonal distribution

Some determining factors:

Social:

- High number of visitors (easy access with train): *Nuria Mountains*.
- Nearness to a very populated area (Barcelona).
- Period of holidays (December: Christmas).

Orographical:

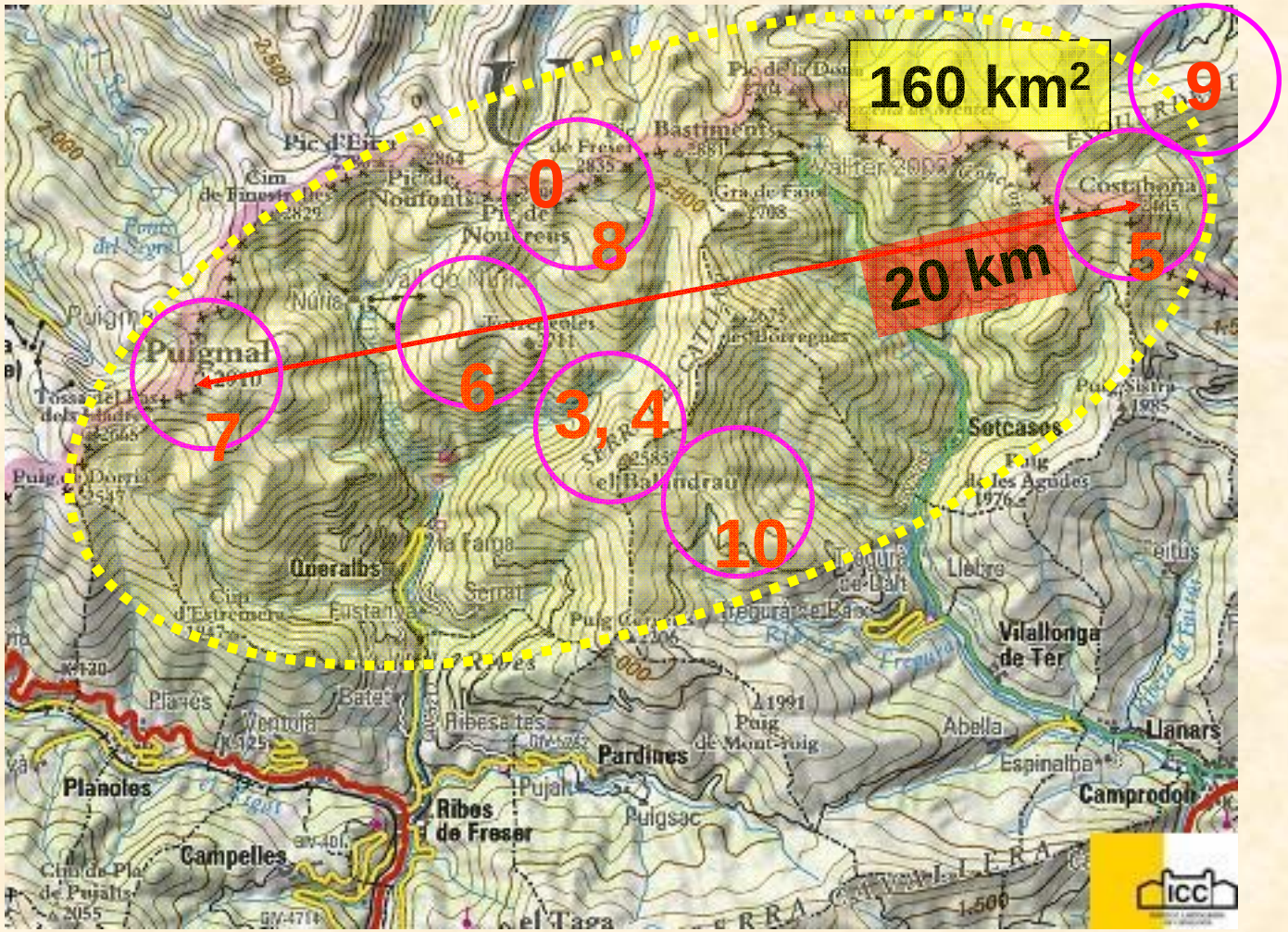
- Mountain form and vegetation: *Nuria Mountains* are soft and rounded but high mountains. Easy hiking. Itineraries over timberline. Alpine meadows.

Meteorological:

- Corner effect in Mediterranean Pyrenees. Frequent winter sudden and strong northerly winds. Strong northerly and westerly winds also affects Montseny massif.

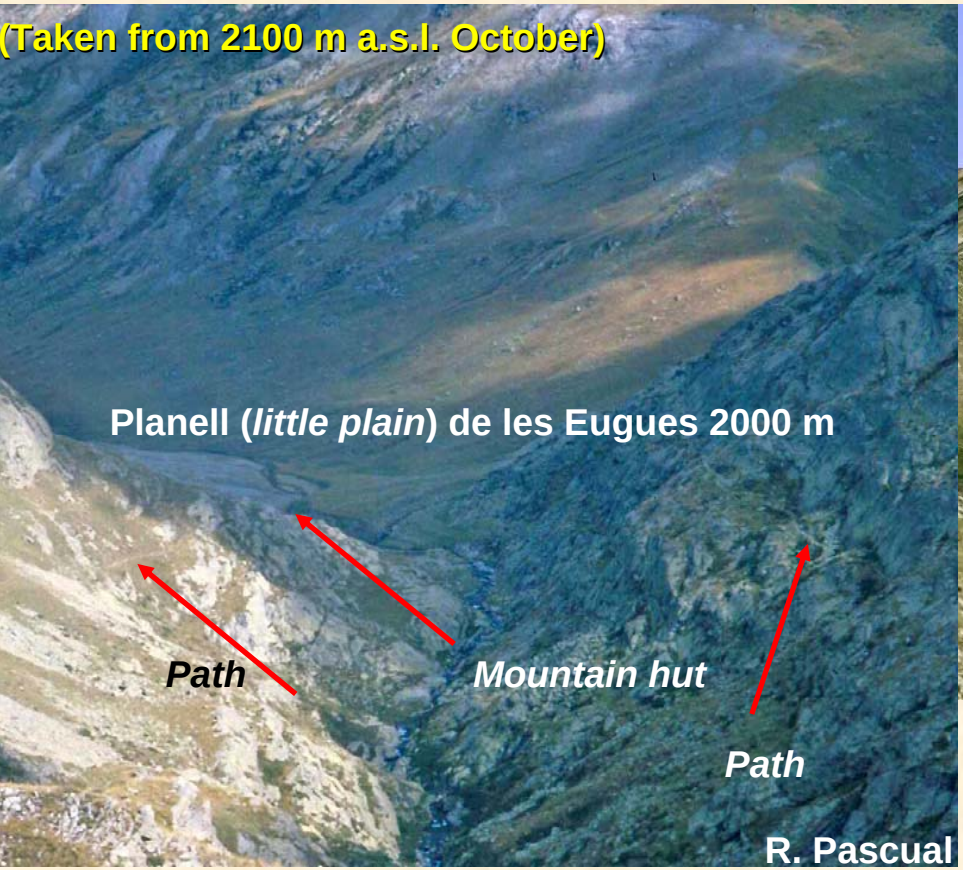
Geographical Features (2)

Nuria Mountains



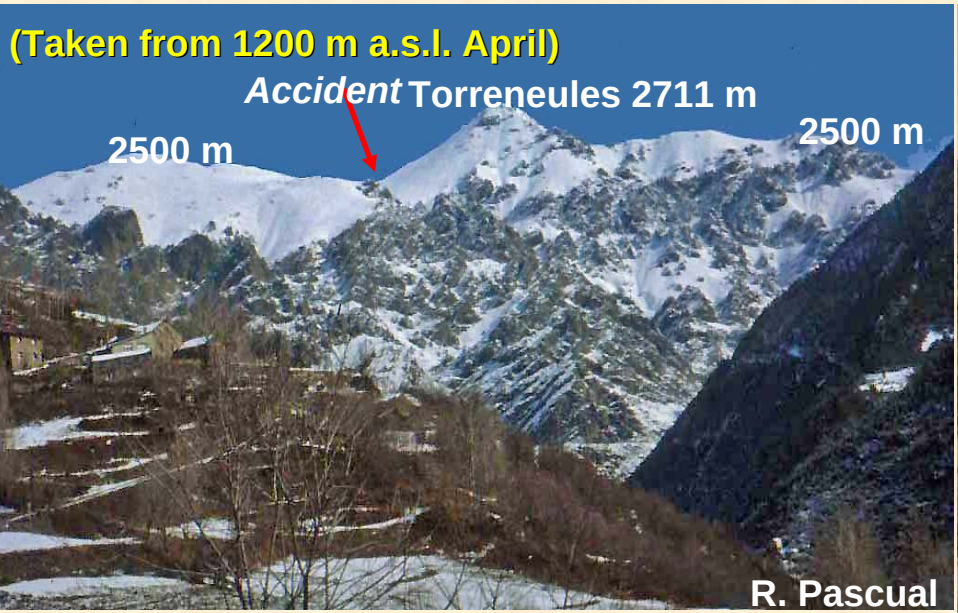
Geographical Features (3)

Cases 3 and 4: Freser Gorges



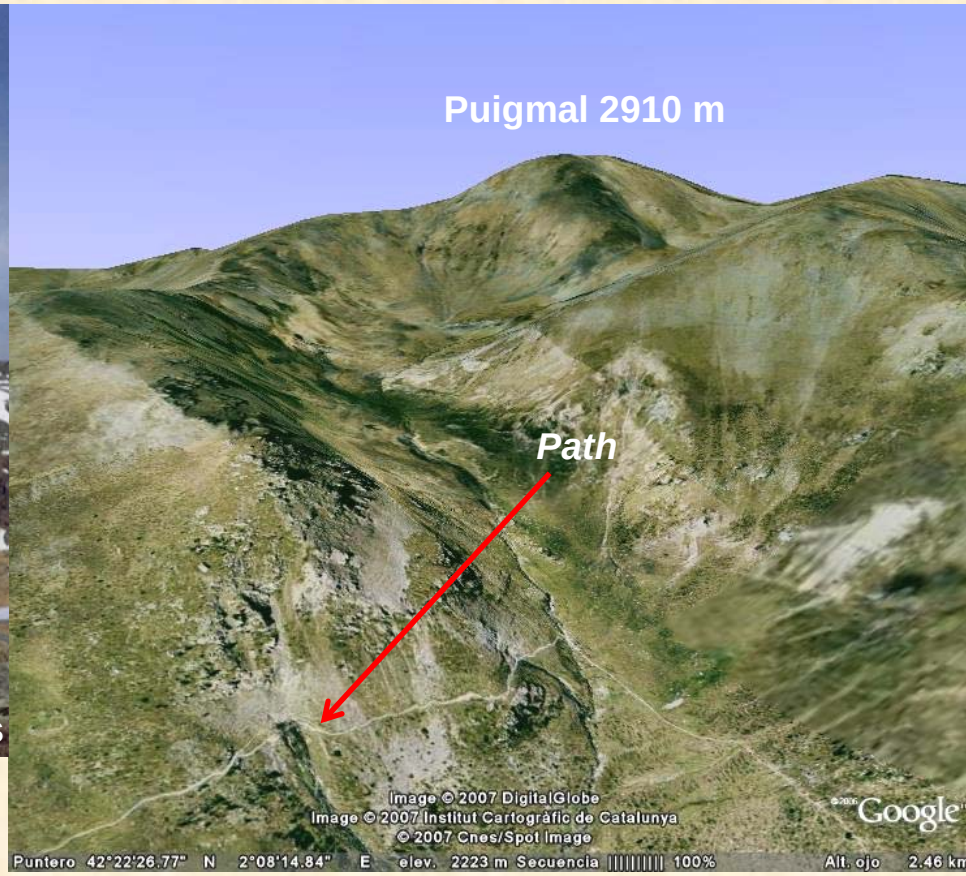
Geographical Features (4)

Case 6: Torreneules Massif



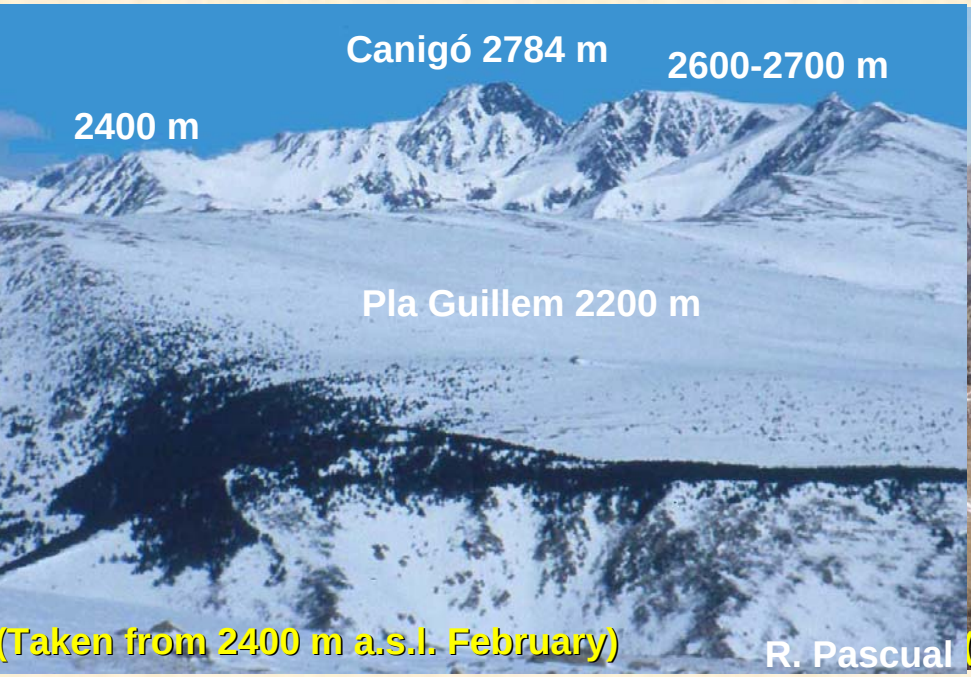
Geographical Features (5)

Case 7: Puigmal Massif



Geographical Features (6)

Case 9: Canigó Massif



Accidents characteristics

Probable cause of death:

- Hypothermia
- Fall in a mountain stream (drowned and/or subsequent hypothermia).
- Fall (contusions and/or subsequent hypothermia).
- Avalanche (contusions, hypothermia and/or asphyxiation).

Probable cause of accident:

- Poor visibility conditions → Disorientation, loss, slip, fall
- Strong winds
- Freezing temperatures } Hypothermia, slip, fall
- Change in surface conditions → Slip, fall
- Change in snow cover stability → Avalanche

Weather conditions (1)

General conditions (Estimated from evidence survivors, newspapers, NCEP and ECMWF reanalysis, scarce observations):

- Rapidly changing conditions.
- Sometimes cloudy or overcast sky.
- Snowfall during accident and/or previous days (fresh, loose snow).
- Low or very low temperatures.
- Strong or very strong winds.
- Extremely low wind chill temperatures.
- Poor visibility because snowfall and/or blowing snow.
- Whiteout conditions.

Hazardous weather conditions comparable to blizzard or ground blizzard.

Local name: *Torb*

Weather conditions (2)

Estimated values of some important variables

> 20 m/s

> 40 m/s

Event Maximum

Case	Temp. (ºC)	Wind Chill (ºC)	300 hPa W (m/s)	700 hPa W (m/s)	850 hPa W (m/s)
1 (Feb.)	-10 /-12	**-23 /-27**	----------	----------	(NE, SFC)
2 (Mar.)	-5 /-10	----------	----------	----------	(NE, SFC)
3 (Dec.)	-8 /-11	-20 /-22	53 (NNW)	21 (NW)	14 (NW)
4 (Mar.)	-1 /-7	-9 /-17	45 (WSW)	20 (W)	10 (W)
5 (Nov.)	-10	**-23**	60 (N)	28 (N) ↔	**30** (N)
6 (Dec.)	-4 /-7	-16 /-19	65 (NNW)	40 (NNW)	**23** (NW)
7 (Nov.)	-4	-12	31 (S)	23 (S)	14 (S)
8 (Dec.)	-14	**-27**	56 (WNW) 44 (NE)	21 (NNW) ↔ 26 (NE)	**24** (N)
9 (Apr.)	-5 /-14	**-14 /-28**	54 (NE)	27 (N)	**25** (N)
10 (Dec.)	-4 (-7)	-14 (-19)	60 (NNW)	24 (N) ↔	**27** (N)
11 (Feb.)	-8 /-13	**-21 /-28**	50 (N)	20 (NNE)	15 (NE)

Synoptic Features (1)

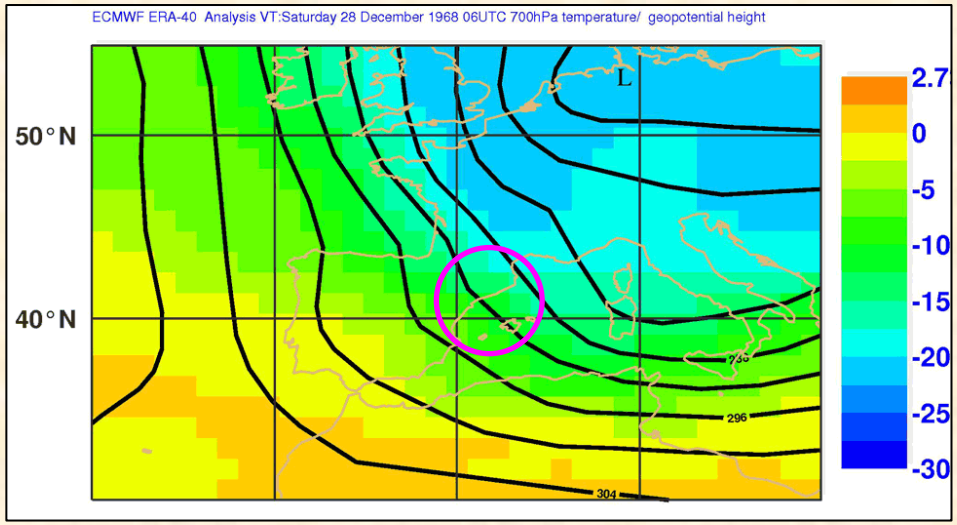
Synoptic situation:

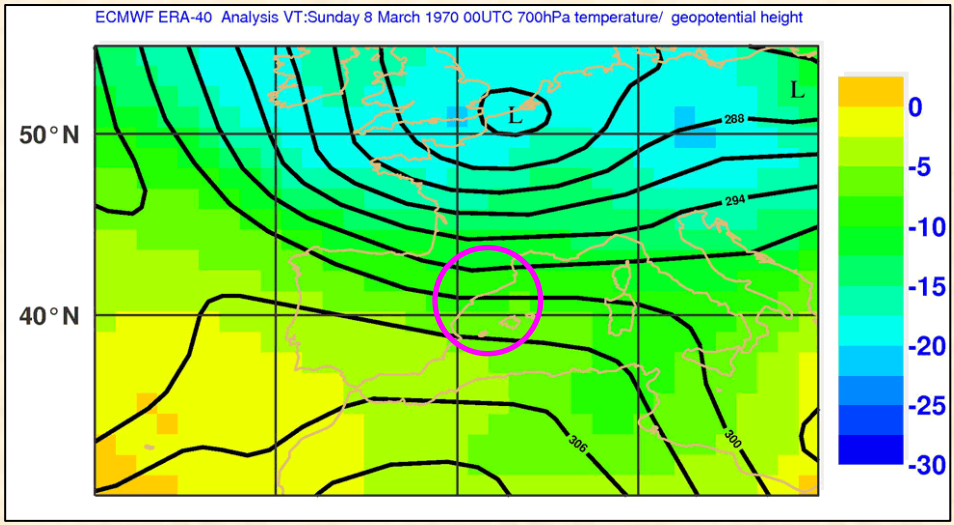
Cold and dry advection. Rapid change of airmass characteristics.

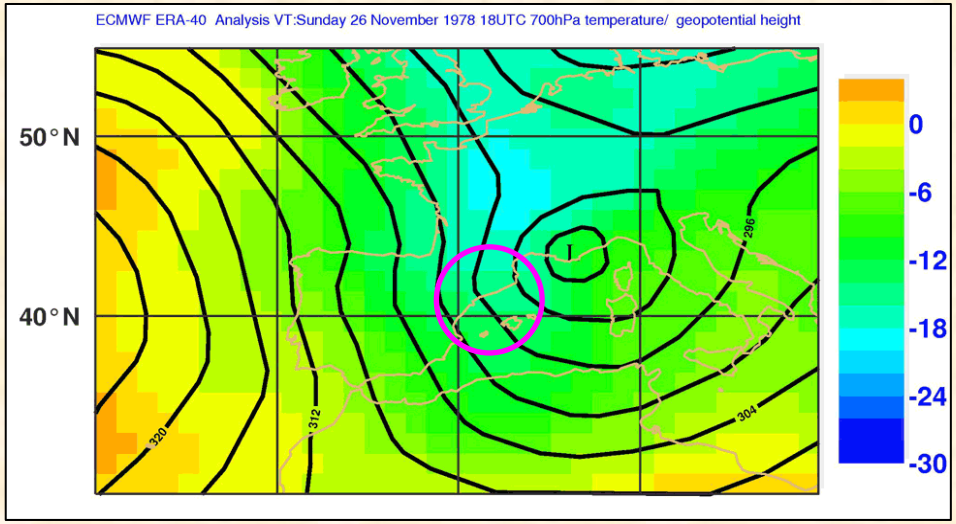
1. Northerly/northeasterly (continental) advection. Cold front ?
2. Northeasterly (continental) adv. Cold front ?
3. Northerly adv. Cold front: NE to SW.
4. Northerly adv. Cold front: N to S.
5. Northerly adv. Cold front: NW to SE.
6. Northerly adv. Cold front: N to S.
7. Southwesterly adv. (warm/wet adv.). Cold front: W to E.
8. Northerly adv. Cold front: N to S.
9. Northerly/northeasterly (continental) adv. Cold front: NW to SE (post-frontal).
10. Northerly/northeasterly (continental) adv. Warm&cold front: N to S.
11. Northeasterly (continental) adv. Cold front: N to S.

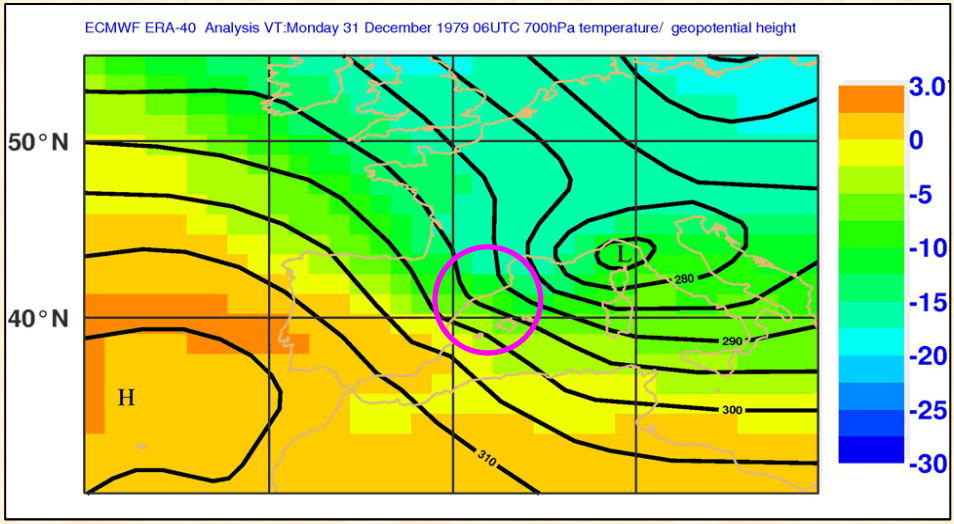
Synoptic Features (2)

700 hPa. Z and T. Cases: 3, 4, 5 and 6.



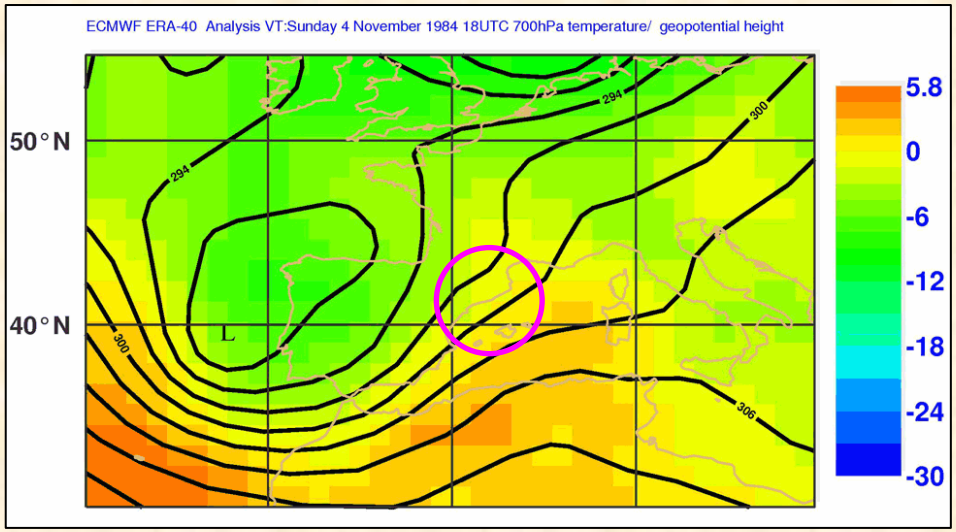


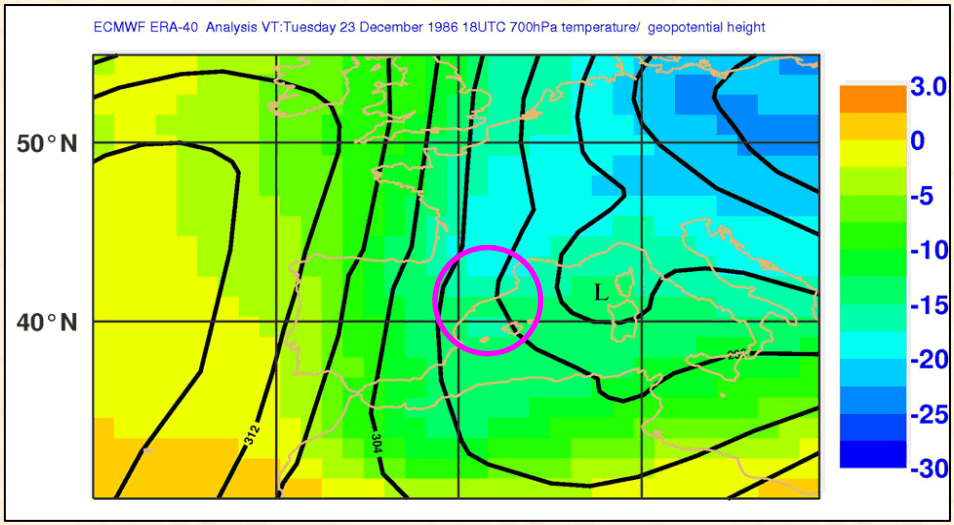


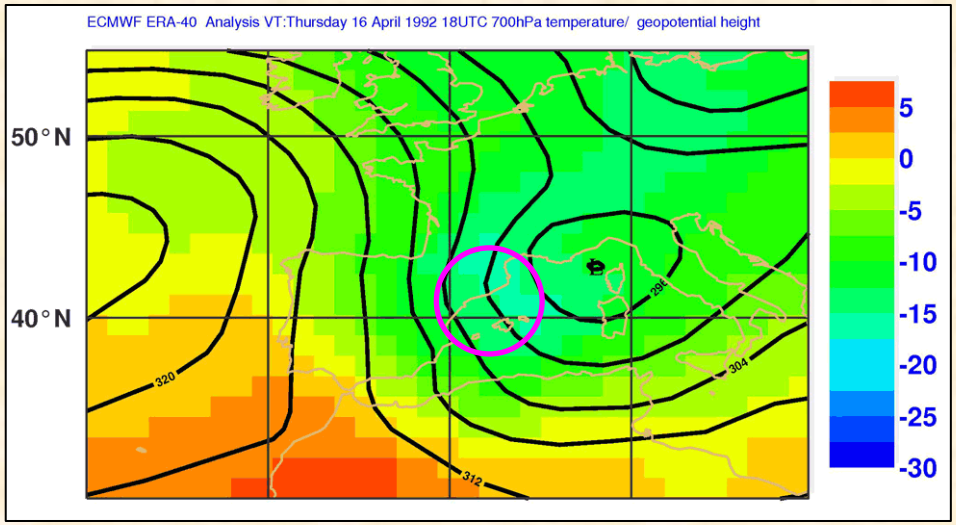


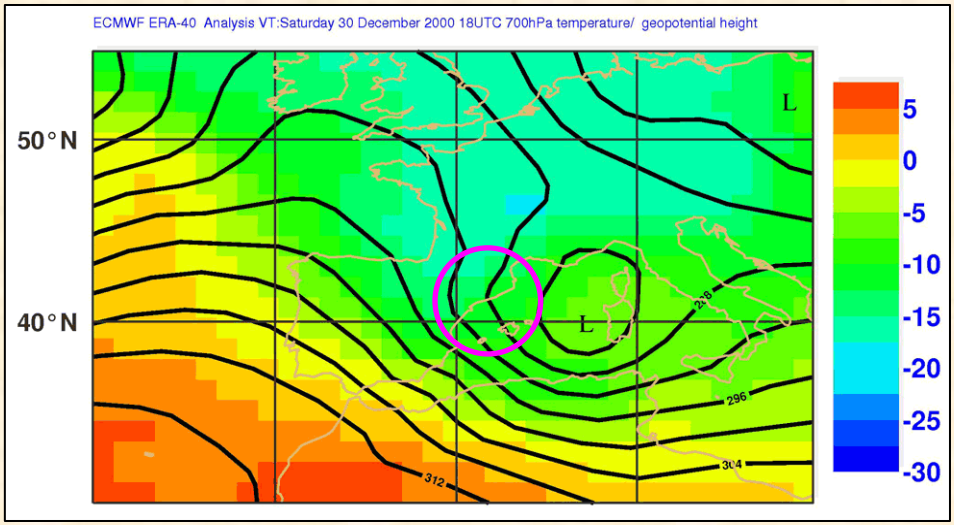
Synoptic Features (3)

700 hPa. Z and T. Cases: 7, 8, 9 and 10.



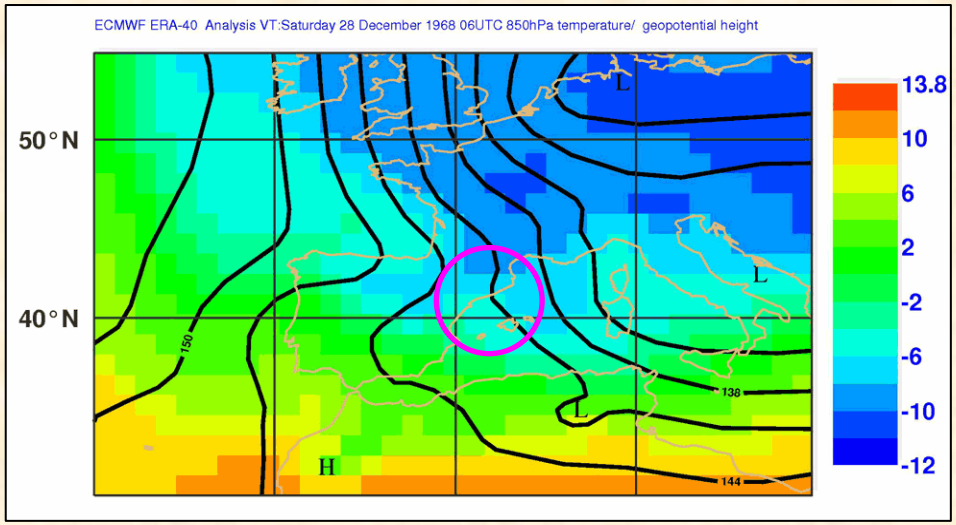


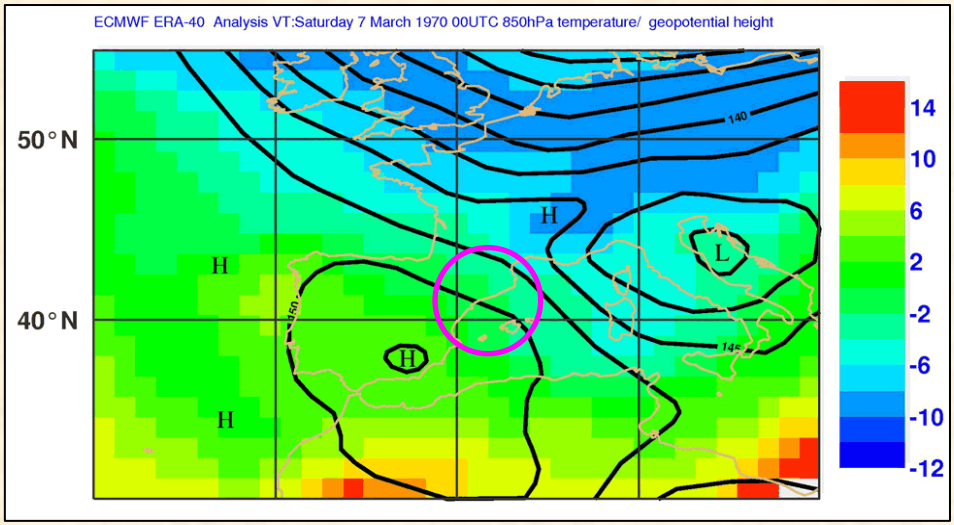


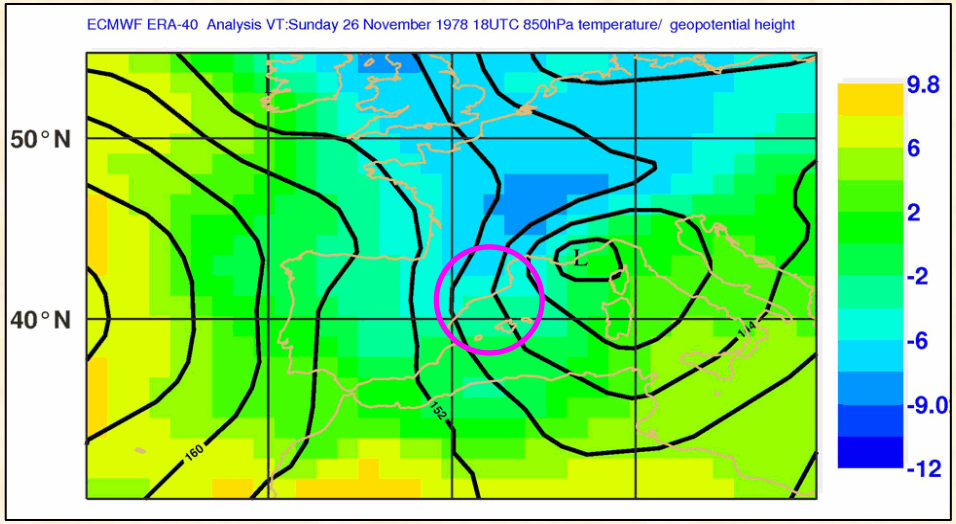


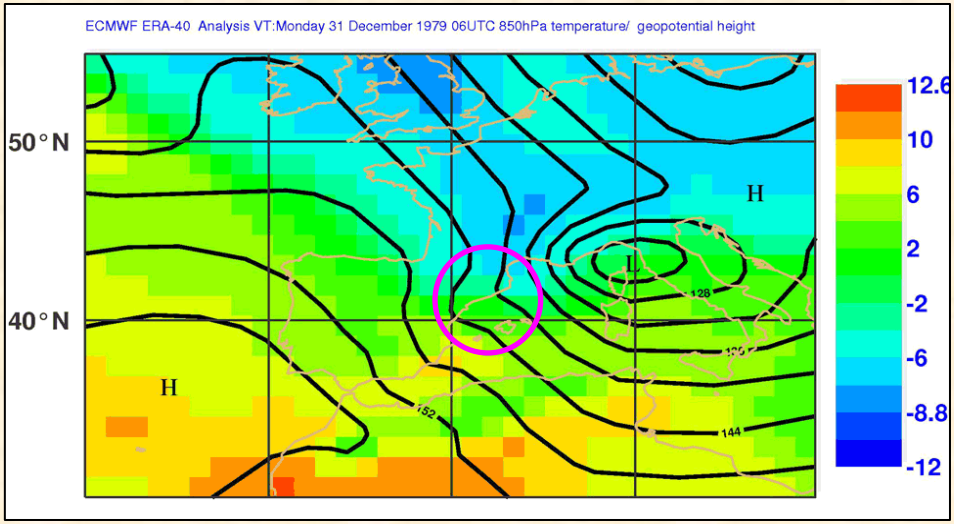
Synoptic Features (4)

850 hPa. Z and T. Cases: 3, 4, 5 and 6.



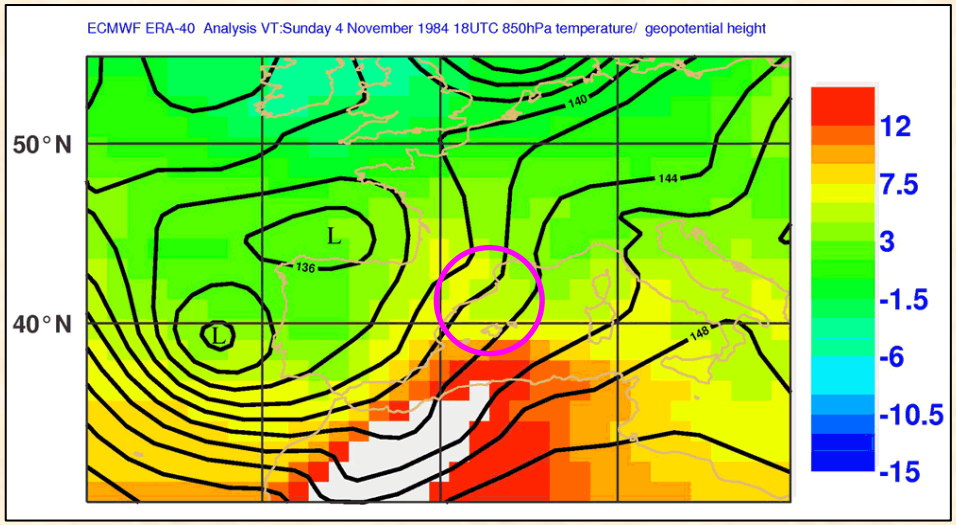


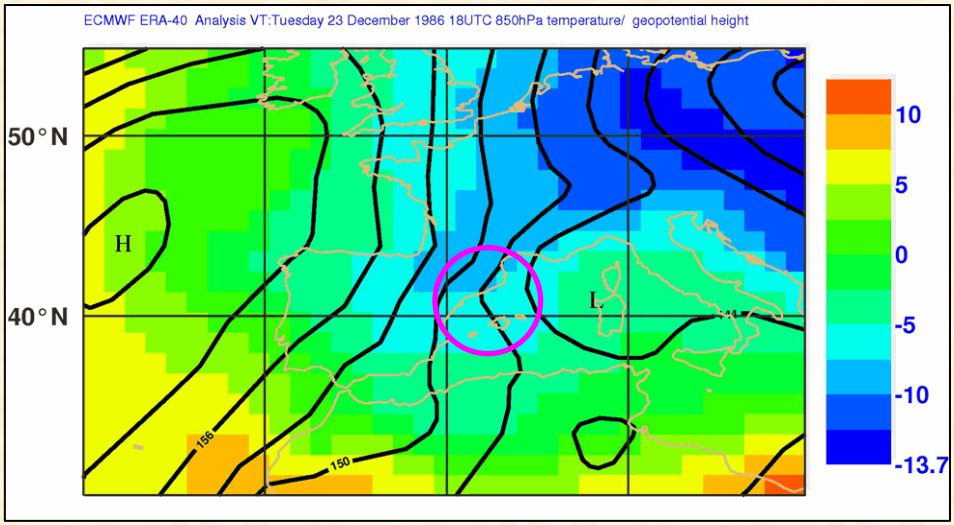


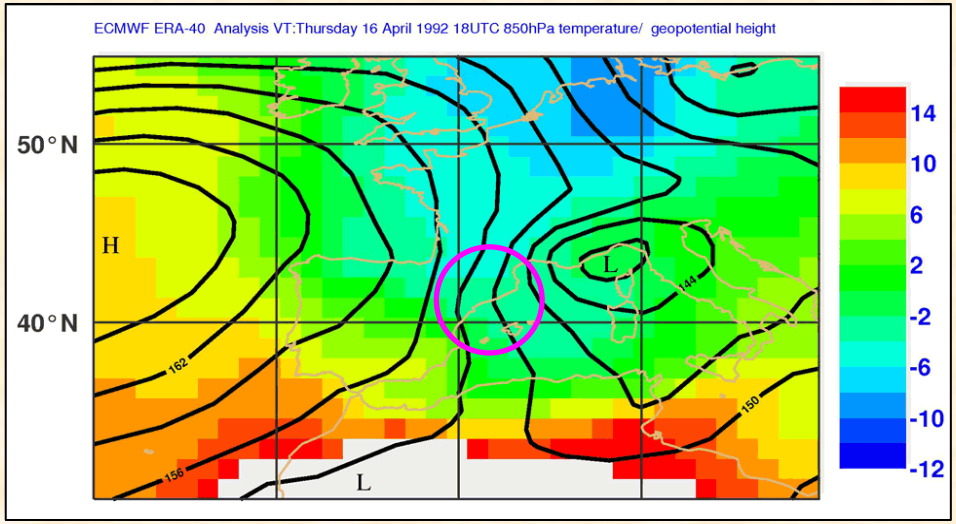


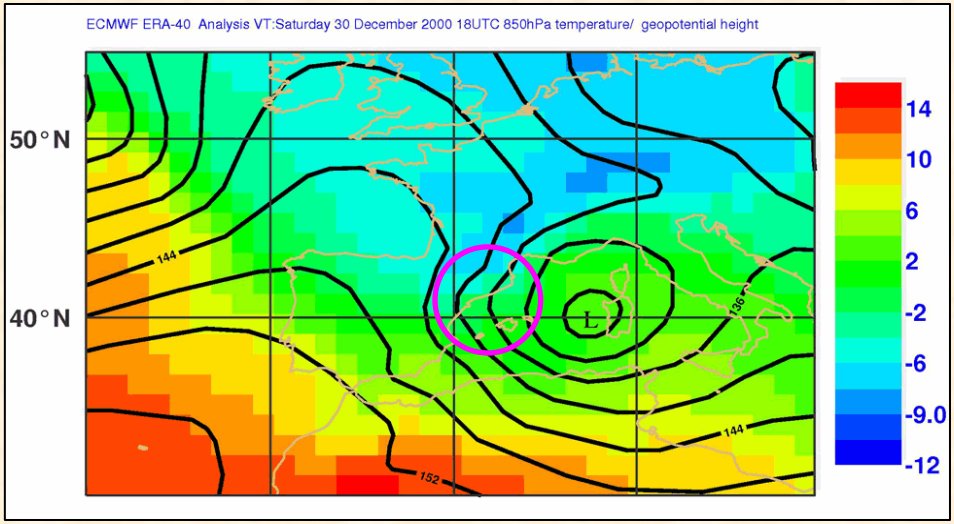
Synoptic Features (5)

850 hPa. Z and T. Cases: 7, 8, 9 and 10.



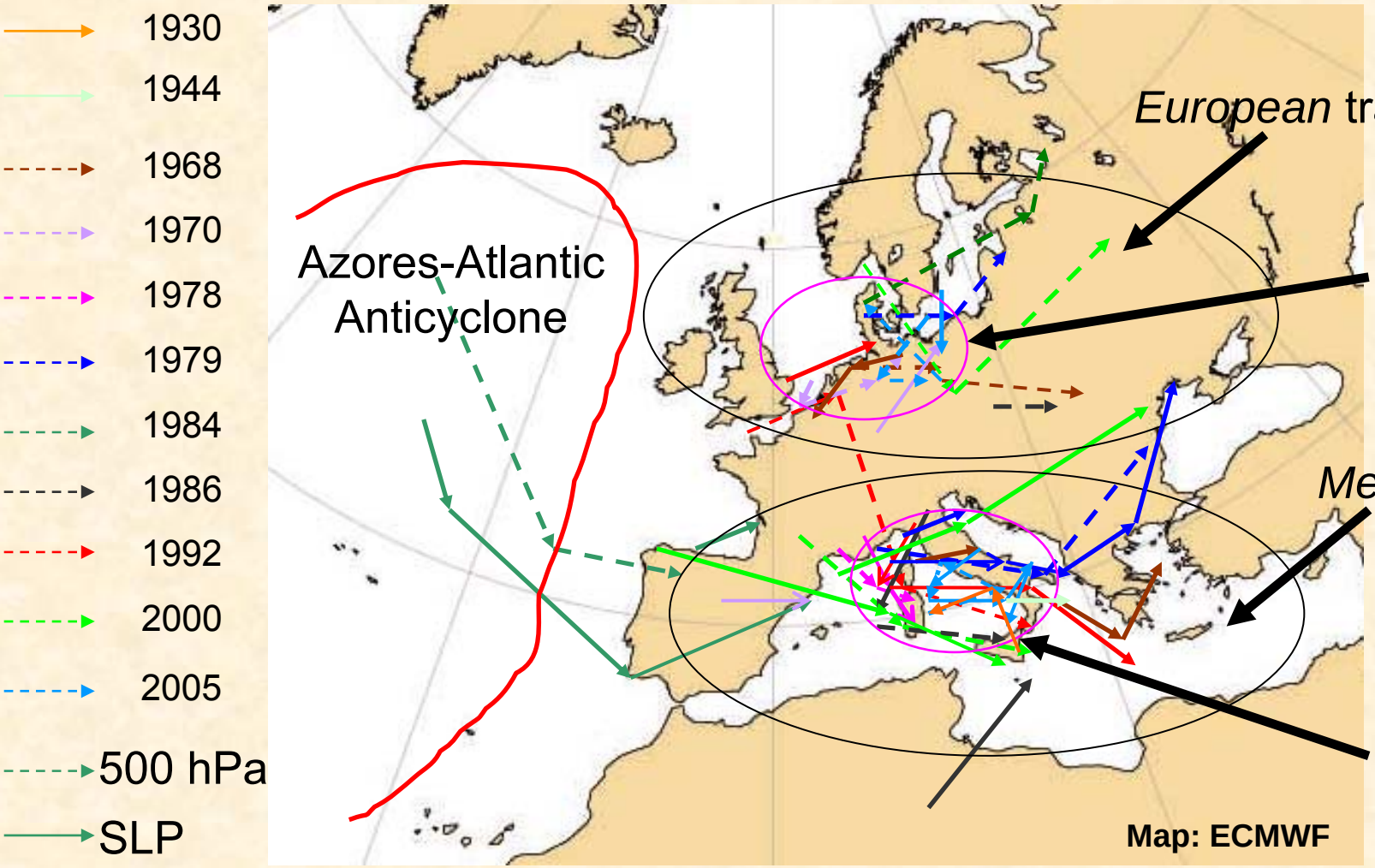






Synoptic Features (6)

CyclonesTracks (500 hPa, SLP). Events.



Synoptic Features (7)

CyclonesTracks (500 hPa, SLP). Events.

General characteristics: Frequent *Mediterranean* cyclogenesis.

Special cases:

1984: Eastward moving *Atlantic low*. SW flow over Pyrenees.

1986: *Algerian* Cyclogenesis.

1992: *North Sea low* with fast Southward displacement.

2000: Very fast eastward moving *Atlantic-Iberian* low.

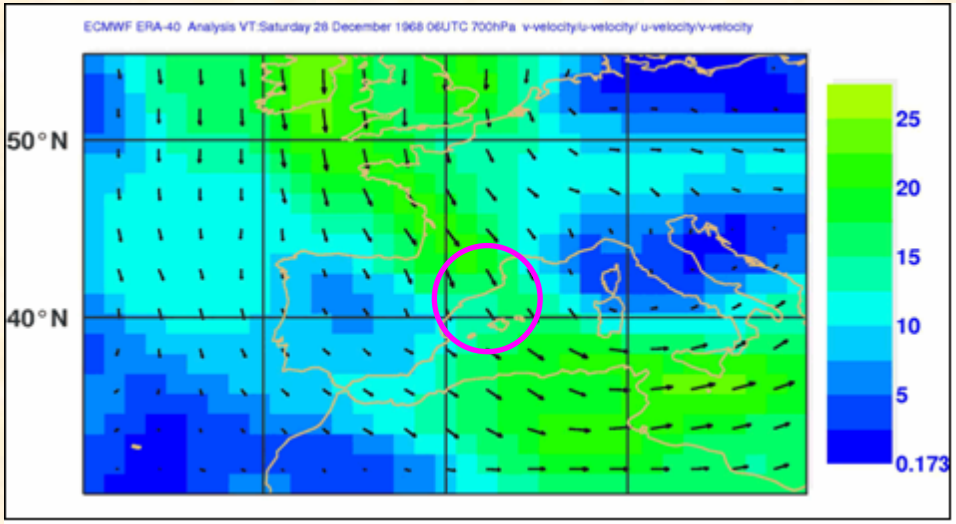
Mesoscale Features (1)

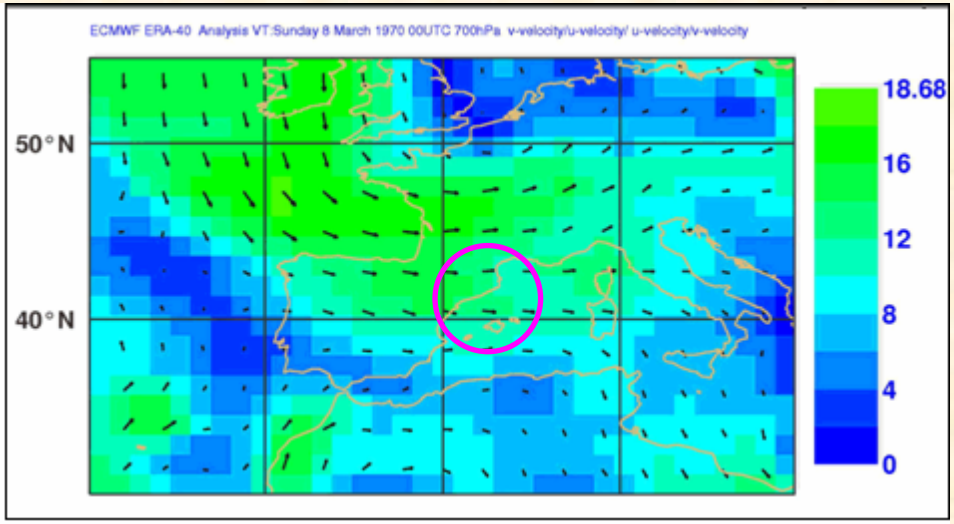
With northerly synoptic flow over Pyrenees:

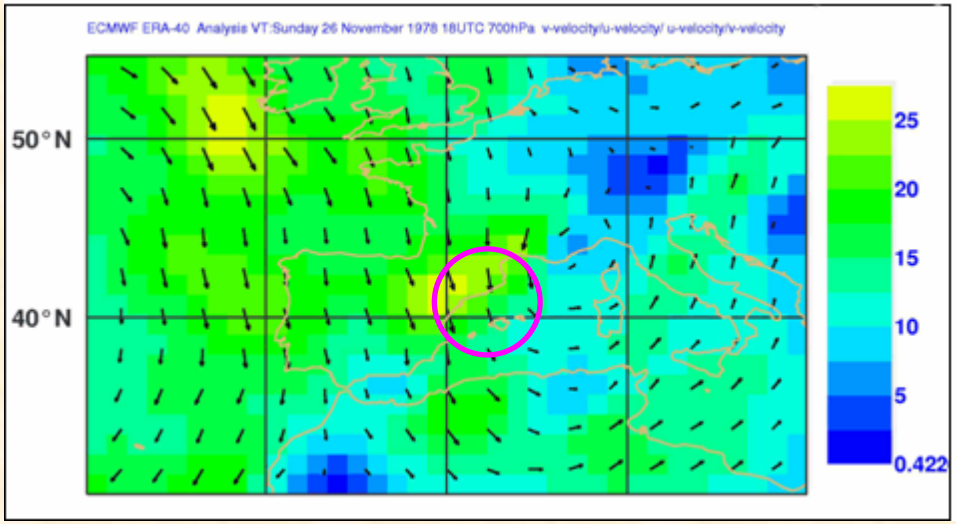
- Mesoscale pressure field deformation (≤ 850 hPa).
- Generation of enhanced regional wind: Tramontane.
- New air mass cold and dry with upstream blocking in the north side of the Pyrenees.
- Strong temperature/humidity gradient across the Pyrenees.
- Probably density current development affecting Mediterranean Pyrenees.
- Complex orography implies local wind acceleration in favourable places.

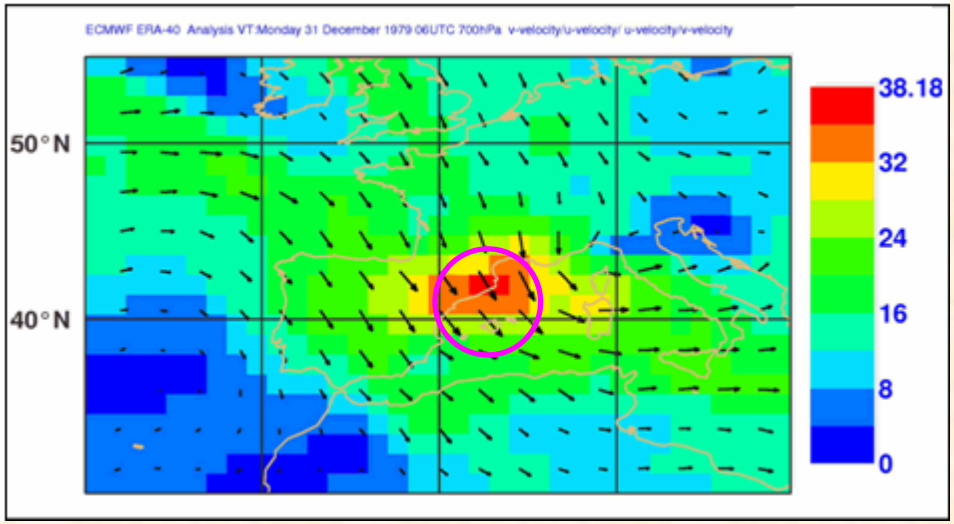
Mesoscale Features (2)

700 hPa. V. Cases: 3, 4, 5 and 6.



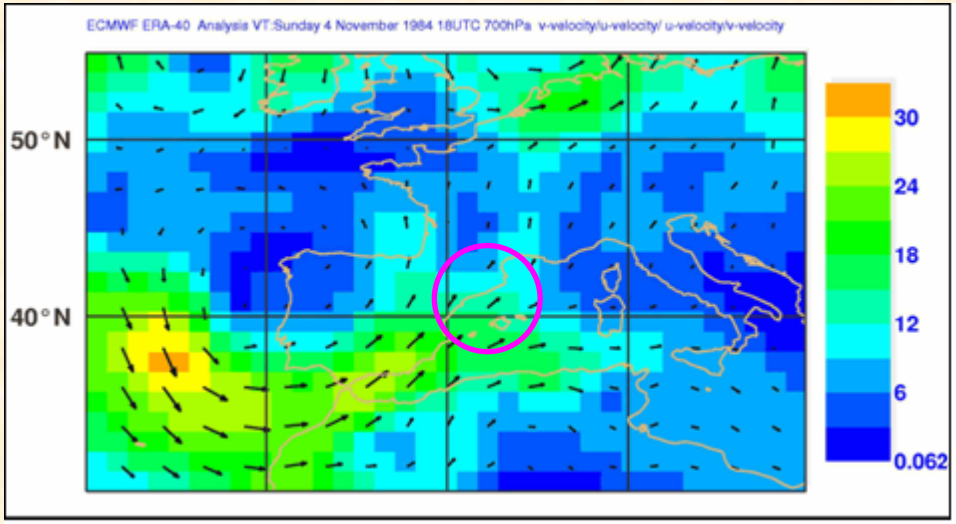


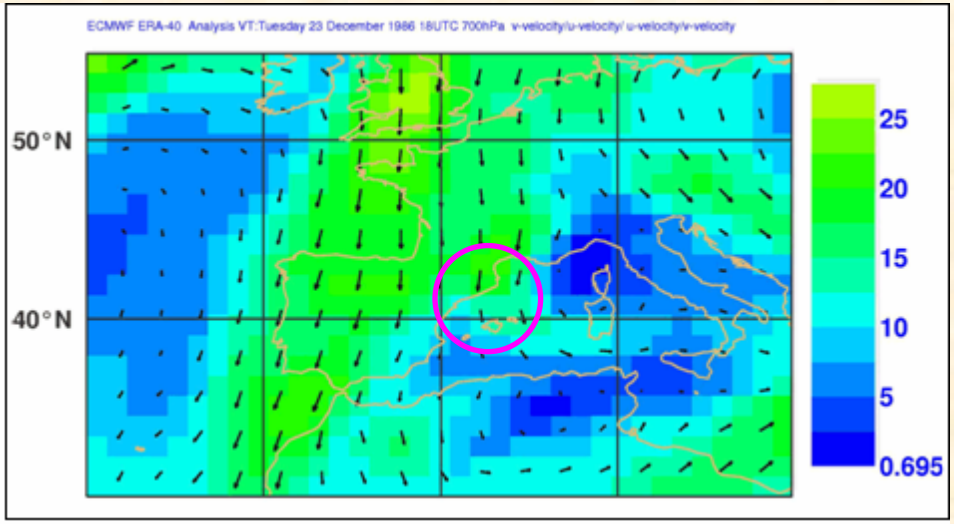


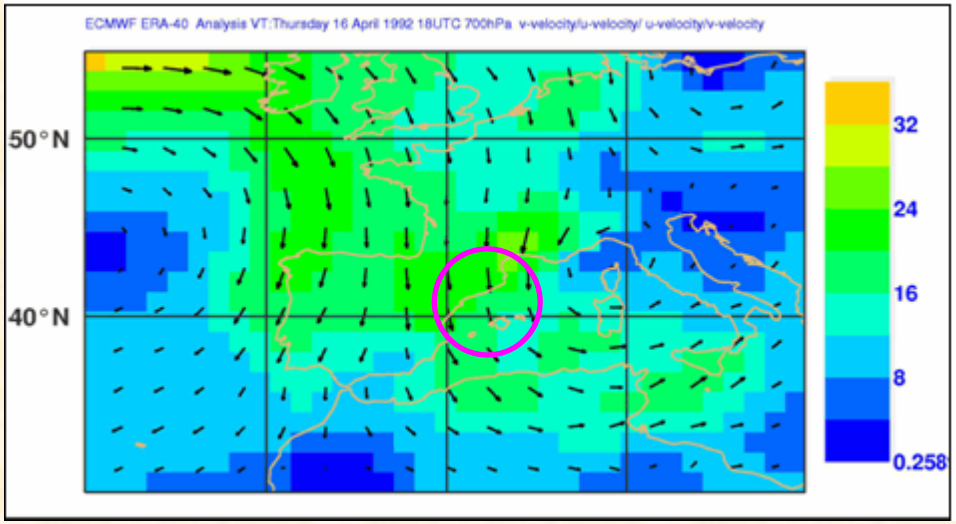


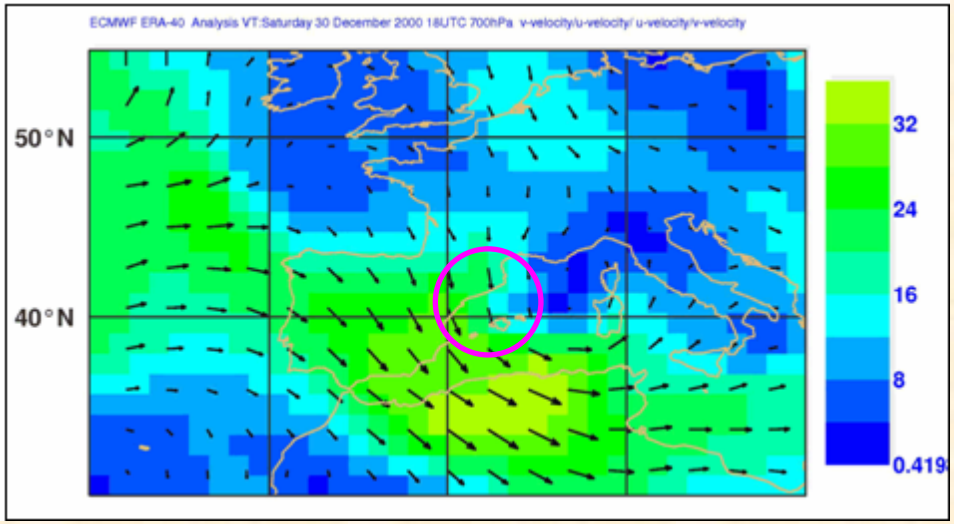
Mesoscale Features (3)

700 hPa. V. Cases: 7, 8, 9 and 10.



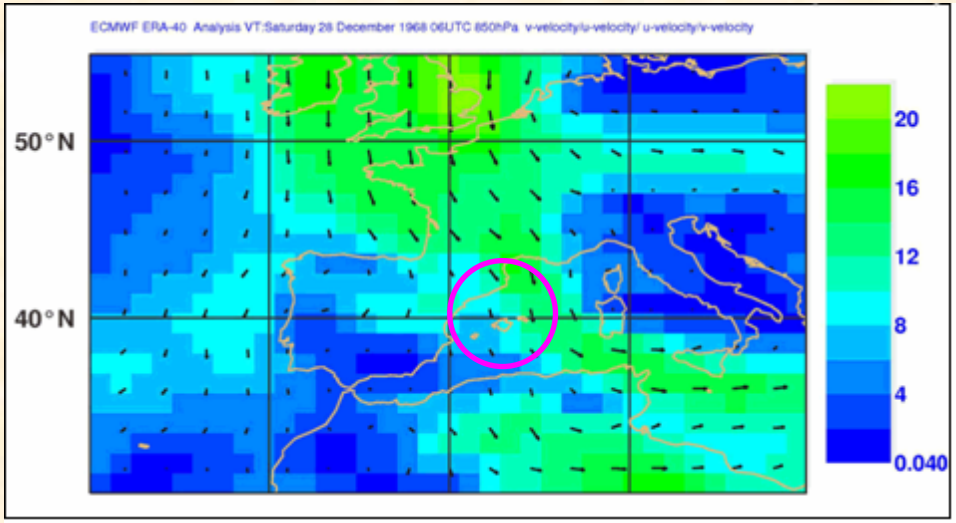


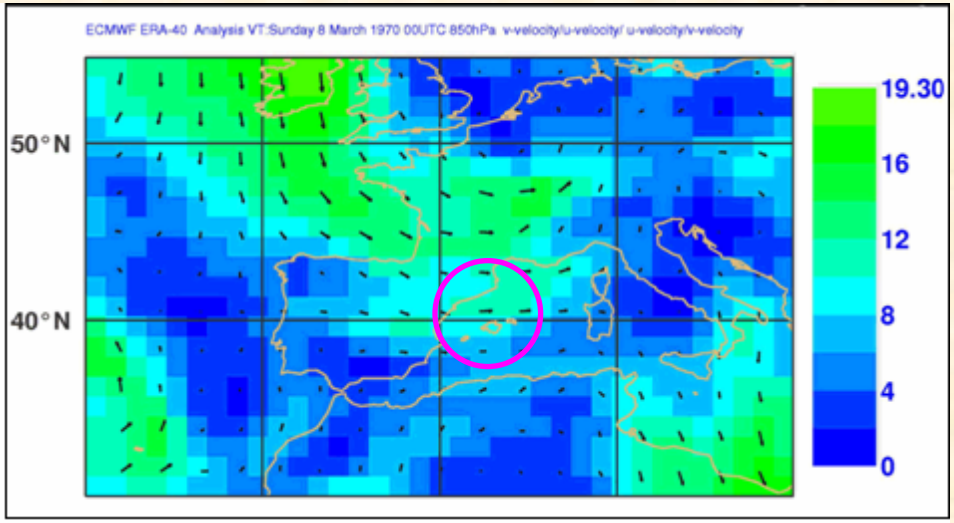


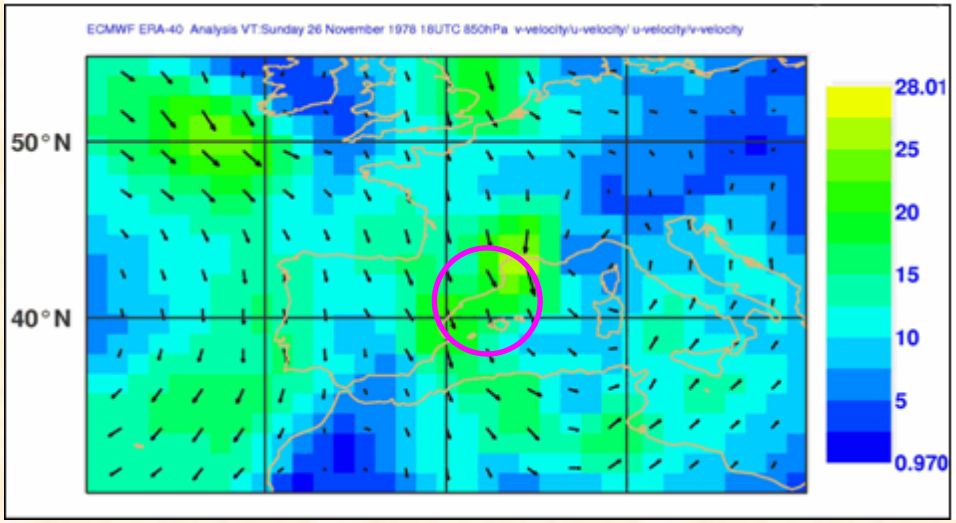


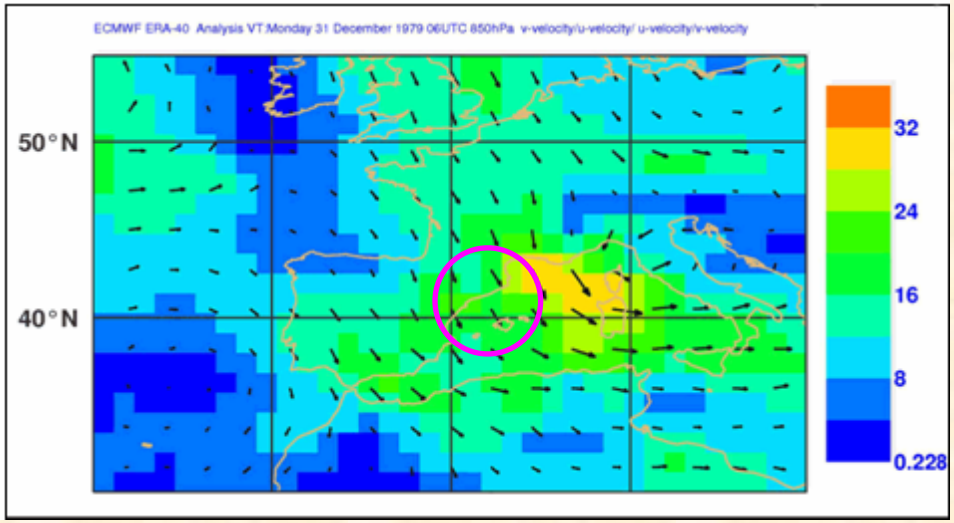
Mesoscale Features (4)

850 hPa. V. Cases: 3, 4, 5 and 6.



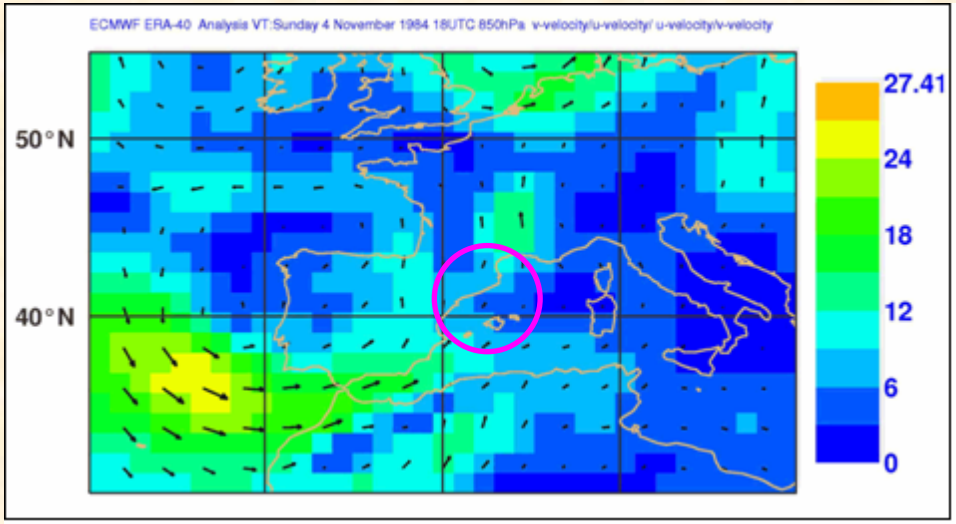


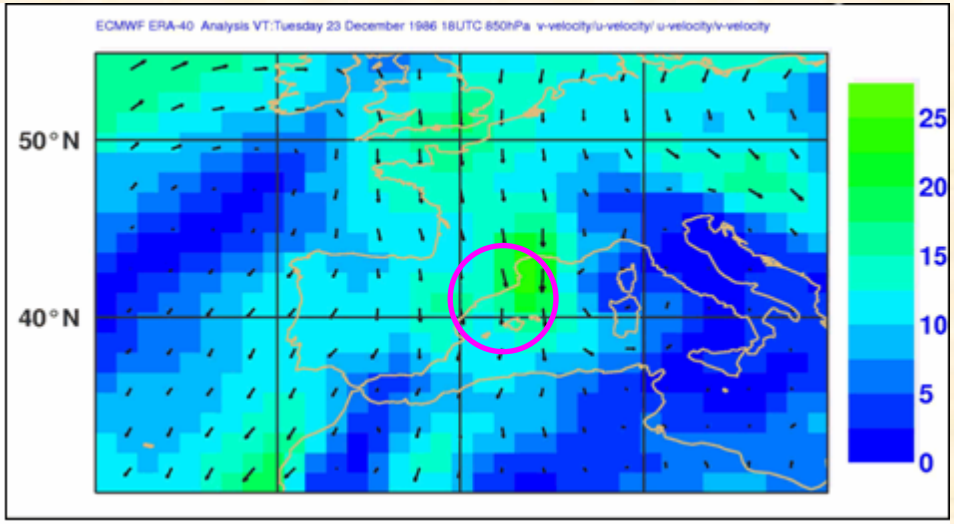


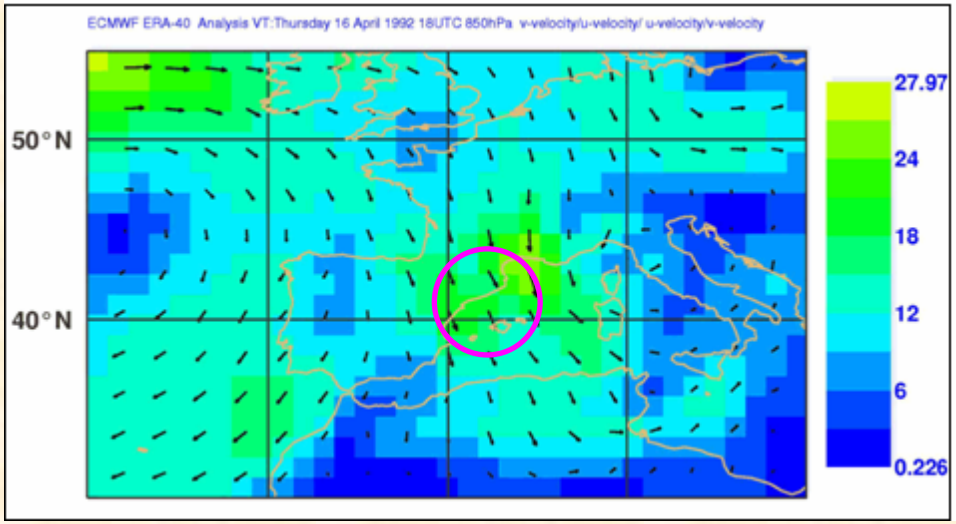


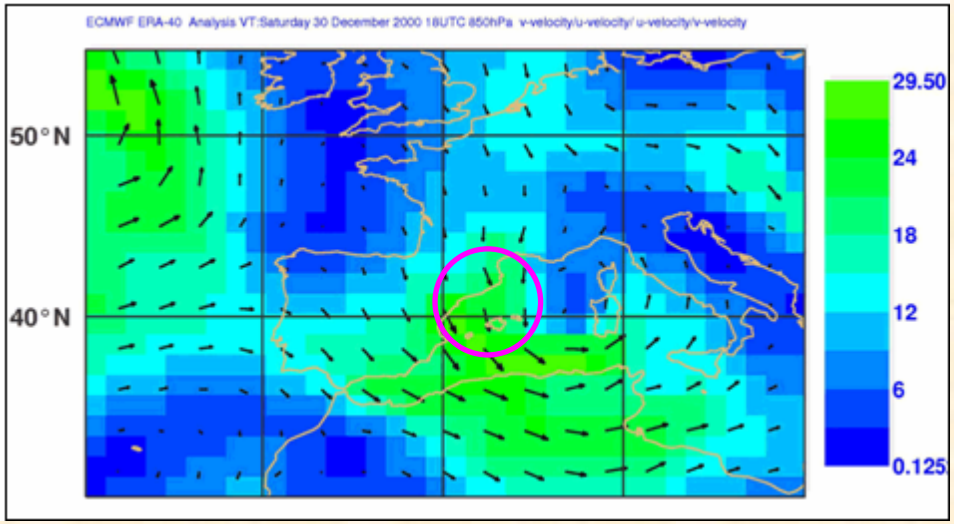
Mesoscale Features (5)

850 hPa. V. Cases: 7, 8, 9 and 10.









Mesoscale Features (6)

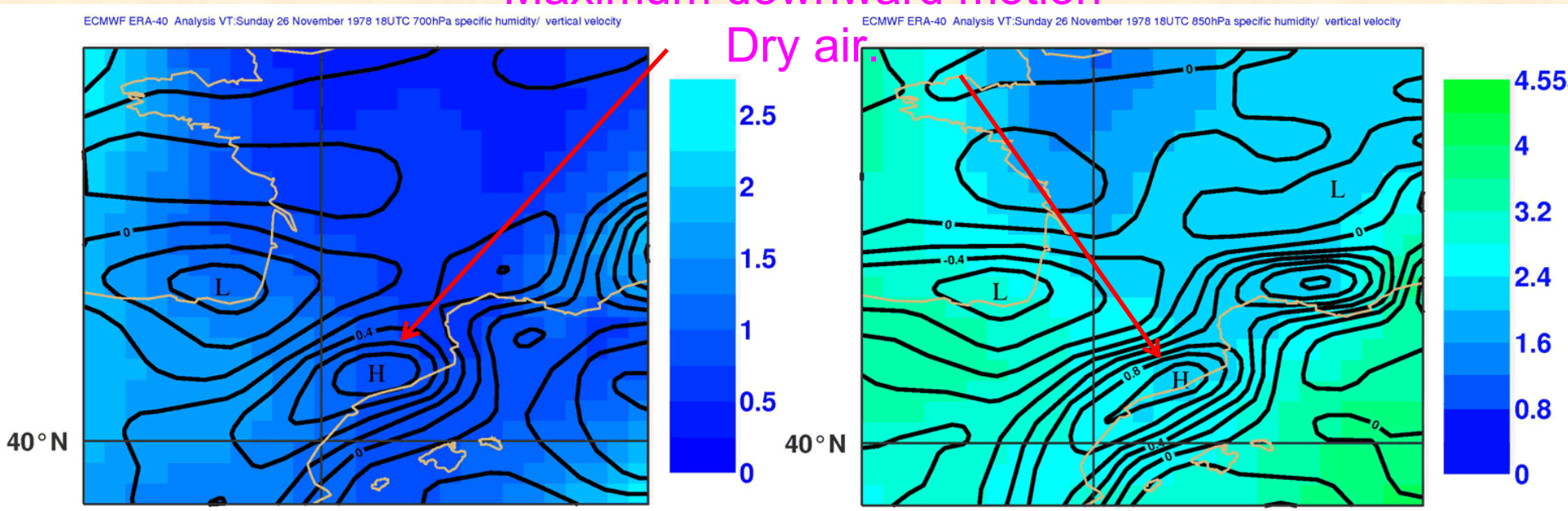
Vertical velocity:

- Cases 3, 4, 5, 6, 8, 9, 10 and 11 show dry air subsiding over the Pyrenees both at 700 hPa and 850 hPa.
- Case 7 (SW flow) shows light upward motion.

Specific humidity and vertical velocity. *26 Nov 1978 @ 18 UTC*

Maximum downward motion

Dry air



700 hPa

850 hPa

Climatic context (1)

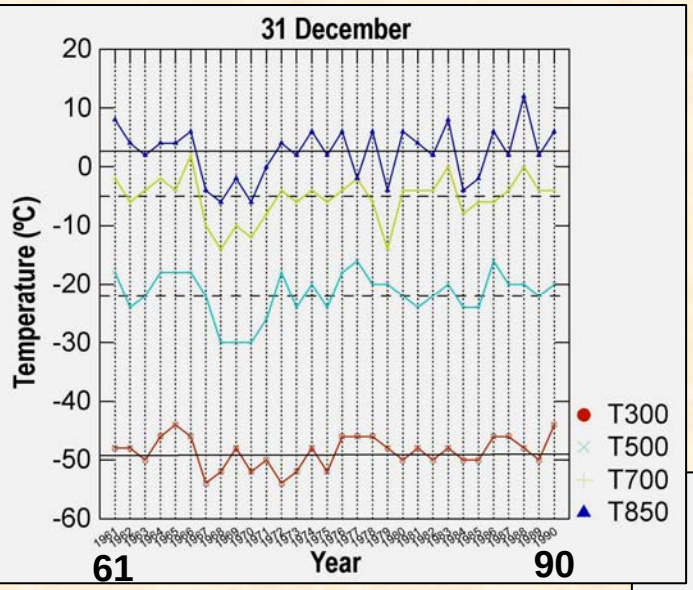
Objective: To compare atmospheric conditions between the selected days with “normal” conditions.

Time series analysis for 3 representative dates (1961-1990):
31 December, 15 February and 31 March (Events: 4 Nov. -- 17 April).
Time: 12 UTC.

Variables analysed: Z@500 hPa, T@300, 500, 700, 850 hPa, SLP, Flow direction@ 500, SFC. Source: ERA-40 ECMWF.

Climatic context (2)

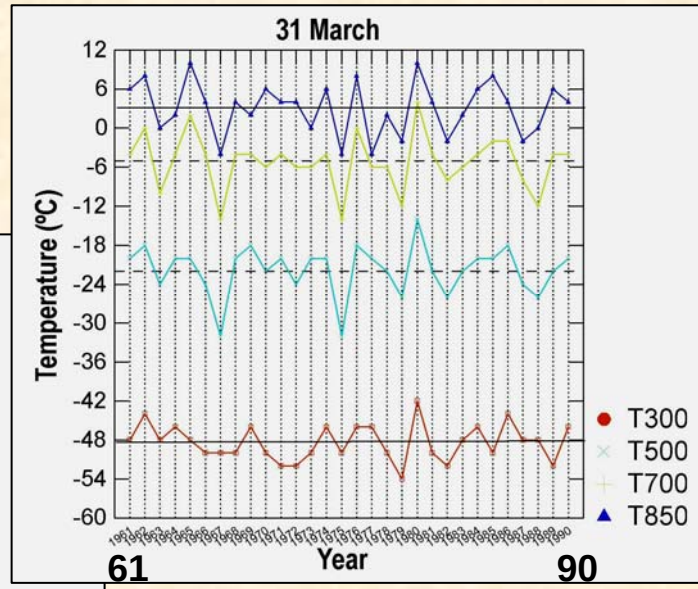
Temperature time series over the Pyrenees

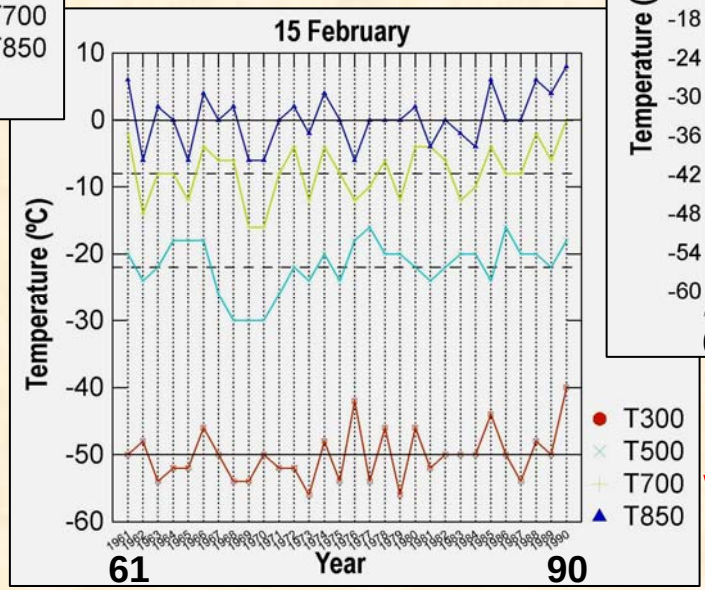


Cold period: 1967-71(73)

Identifiable in 4 levels and 3 dates.

Accidents: 1968, 1970.





T850 Vs T700: good correlation.

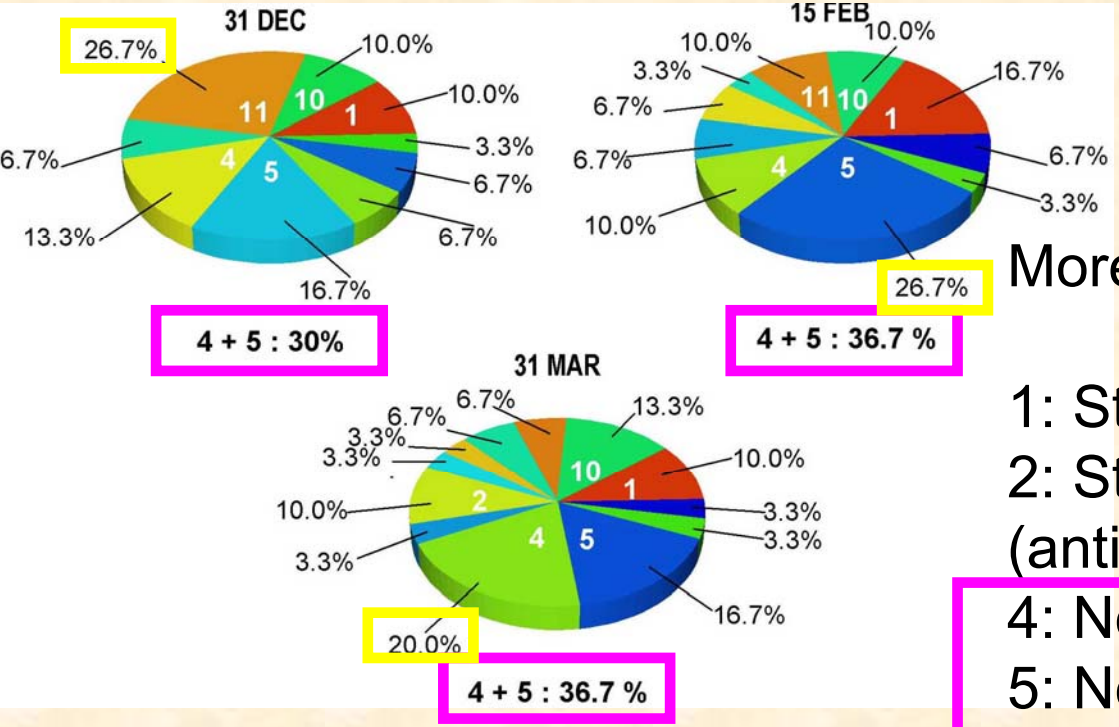
Pearson's corr. ≥ 0.8

Coldest date: 15 Feb.

Warmest date: 31 March.

Climatic context (3)

Climatological synoptic patterns over Pyrenees

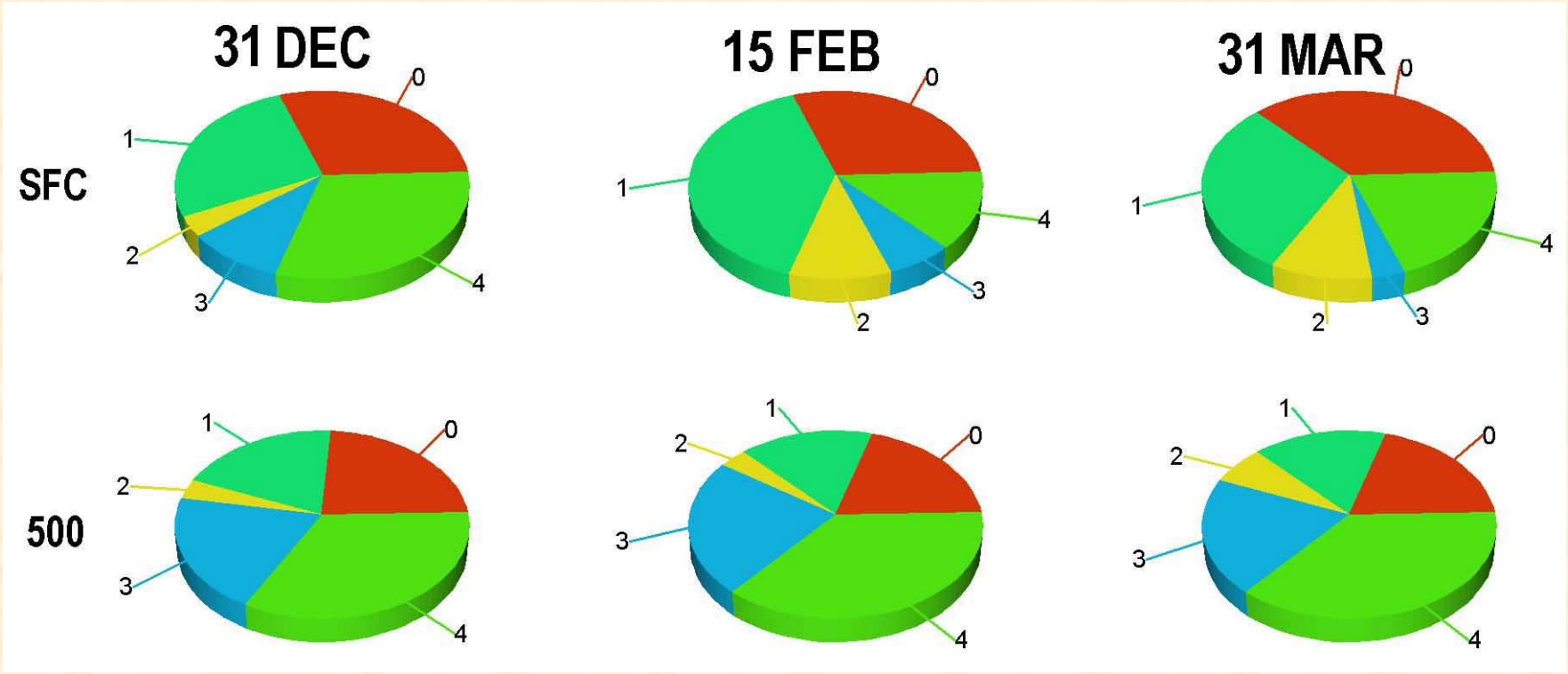


More frequent patterns (≥ 10 %):

1: Strong westerly flow (cyclonic)
2: Strong westerly flow (anticyclonic)
4: Northerly advection
5: Northeasterly (european) advection
≥ 30 %
10: Centred cold low
11: Centred dynamic anticyclone

Climatic context (4)

Normal Flow direction over Pyrenees



500 hPa. Higher frequency (3 dates): Flow from 4 and 3 (W/NW; S/SW).
SFC. Higher frequency: Flow from 4 and 1 (W/NW; N/NE) (Dec.)
Flow from 1 and 4 (Feb., Mar.)

Climatic context (5)

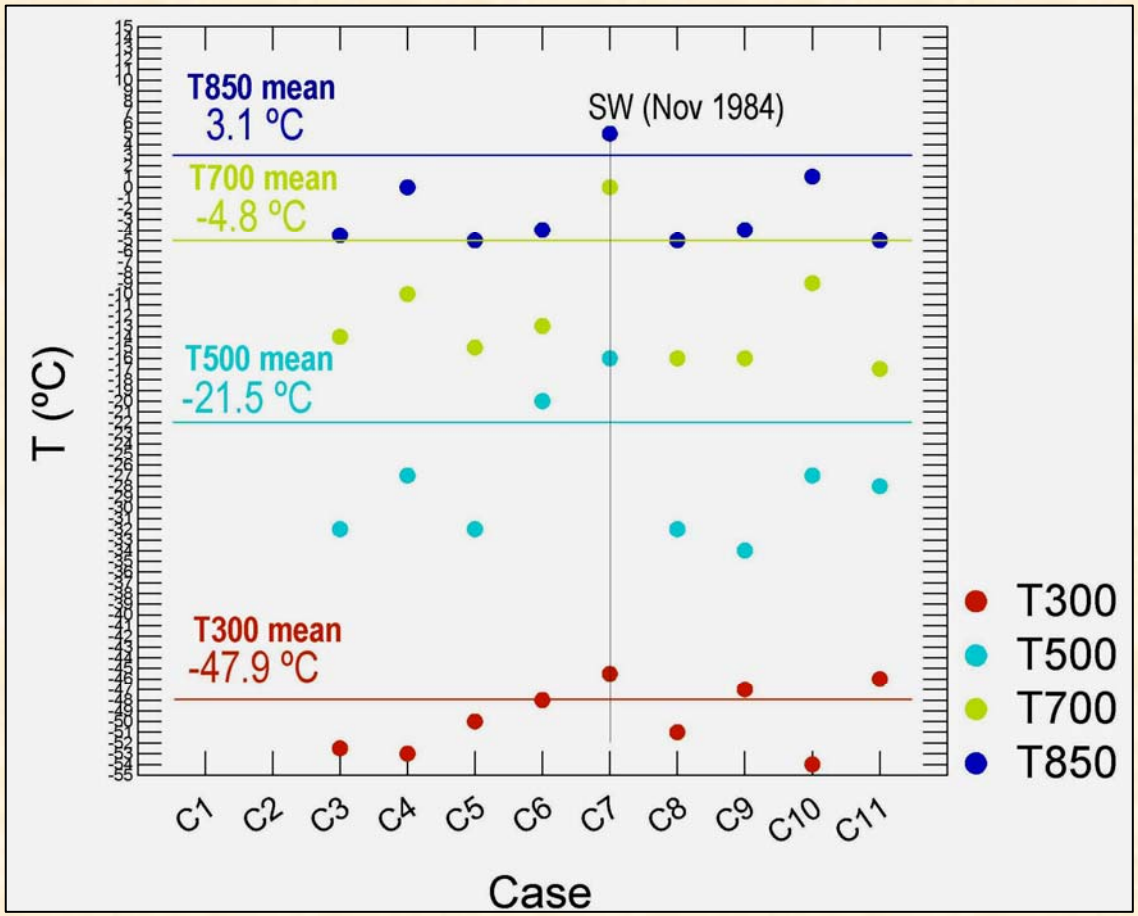
Flow direction Vs Temperature

	T300 (º C)	T500 (º C)	T700 (º C)	T850 (º C)
31 DEC NE/NW	-49.5/ -47.3	-23.0/ -20.9	**-7.5**/ -5.6	**-0.8**/ 2.9
31 DEC MEAN	-48.7	-21.7	-5.3	2.4
15 FEB NE/NW	-50.5/ -52.0	-22.2/ -21.0	**-11.0**/ -7.5	**-2.5**/ 1.5
15 FEB MEAN	-50.1	-21.8	-7.7	0.1
31 MAR NE/NW	-49.2/ -46.3	**-25.1**/ -19.3	**-9.3**/ -2.7	**-0.2**/ 5.3
31 MAR MEAN	-48.4	-21.8	-5.2	3.1

Flow from 1(N/NE): Temperature < mean in all levels and dates.
Flow from 4(W/NW): Depending on actual configuration (airmass).

Climatic context (6)

Temperature over Pyrenees: Events vs 40 years reanalysis, Monthly means. Mean from November to April.

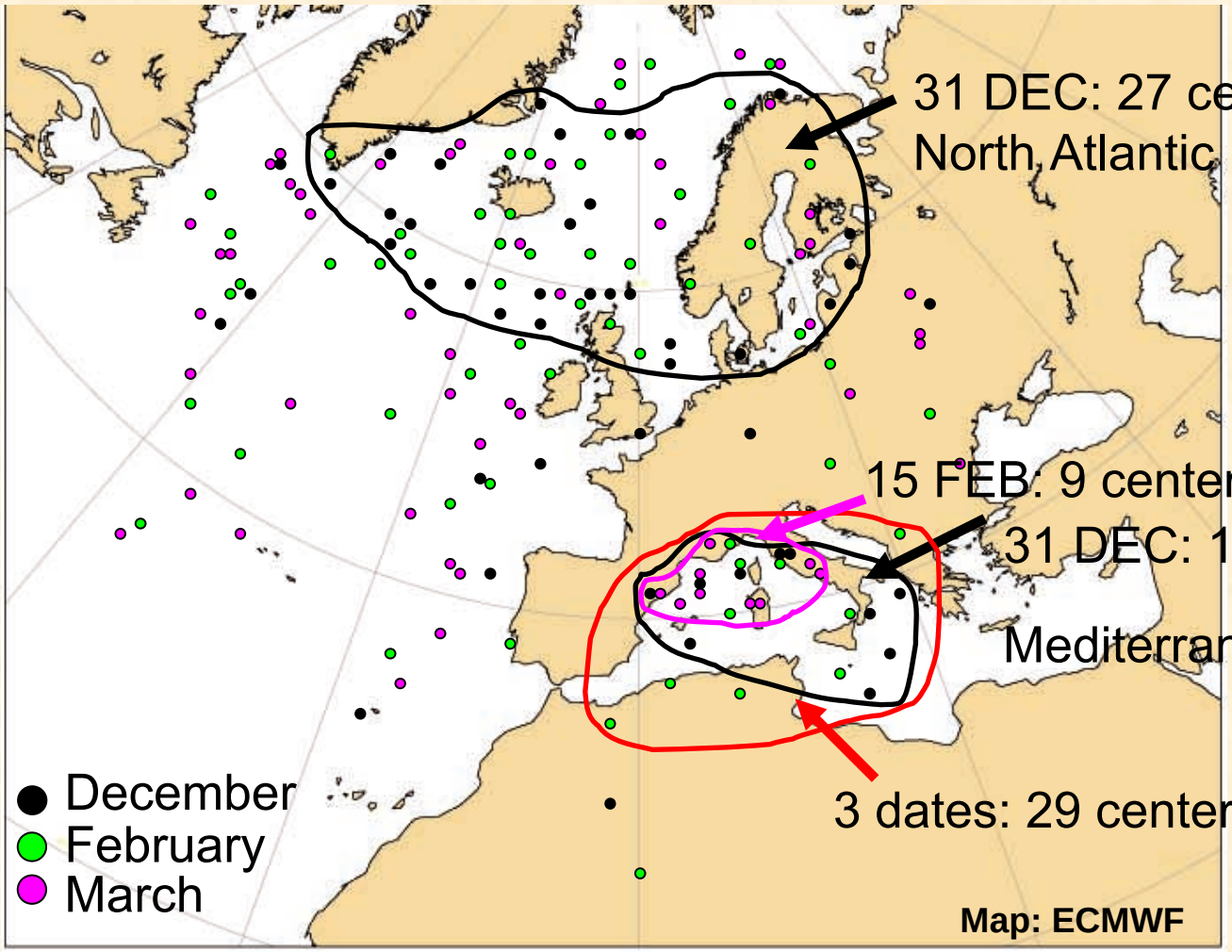


Events temperature < mean

Exception: Case 7@1984. SW advection.

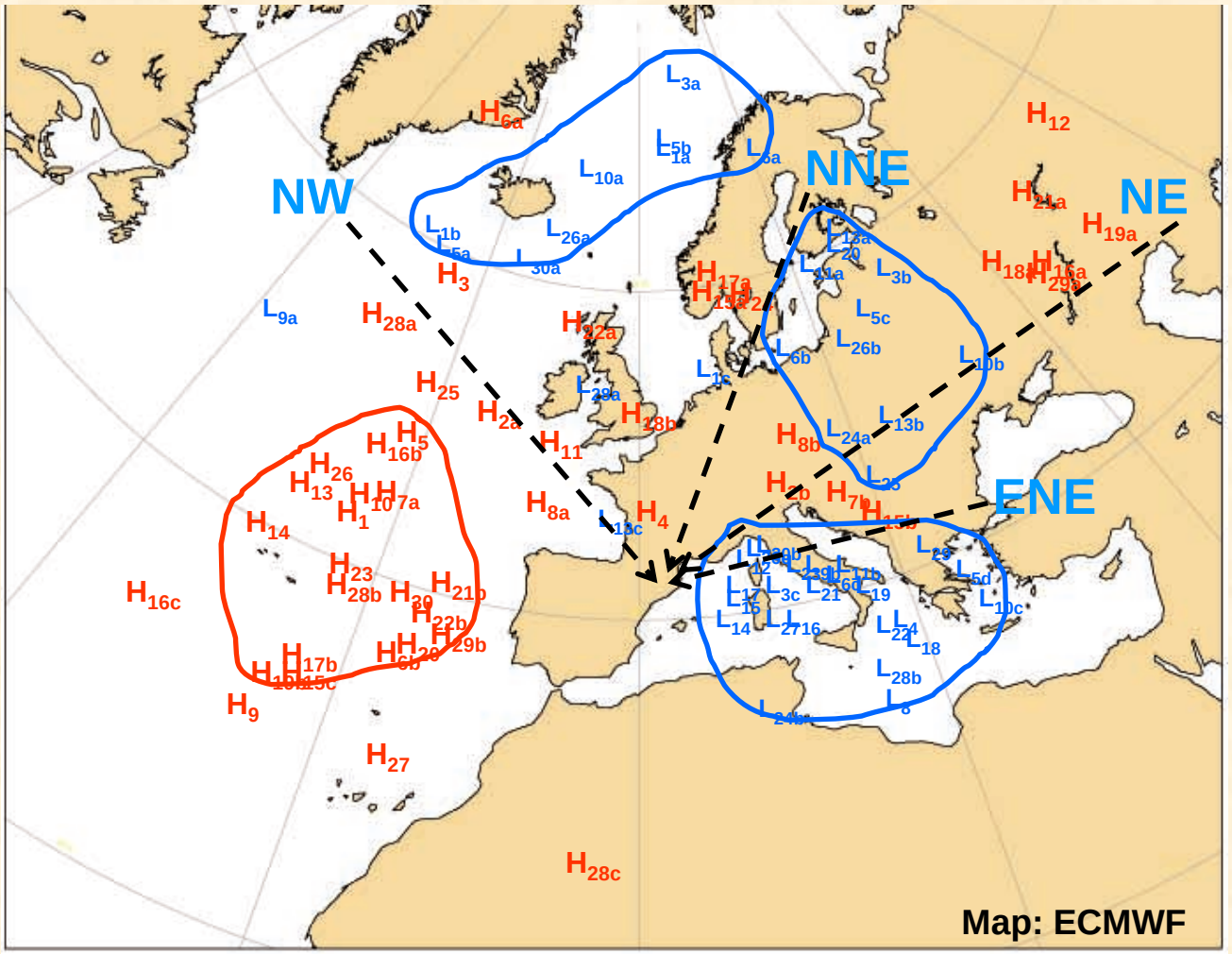
Climatic context (7)

Geographical location of low centers (SL). 30 years.



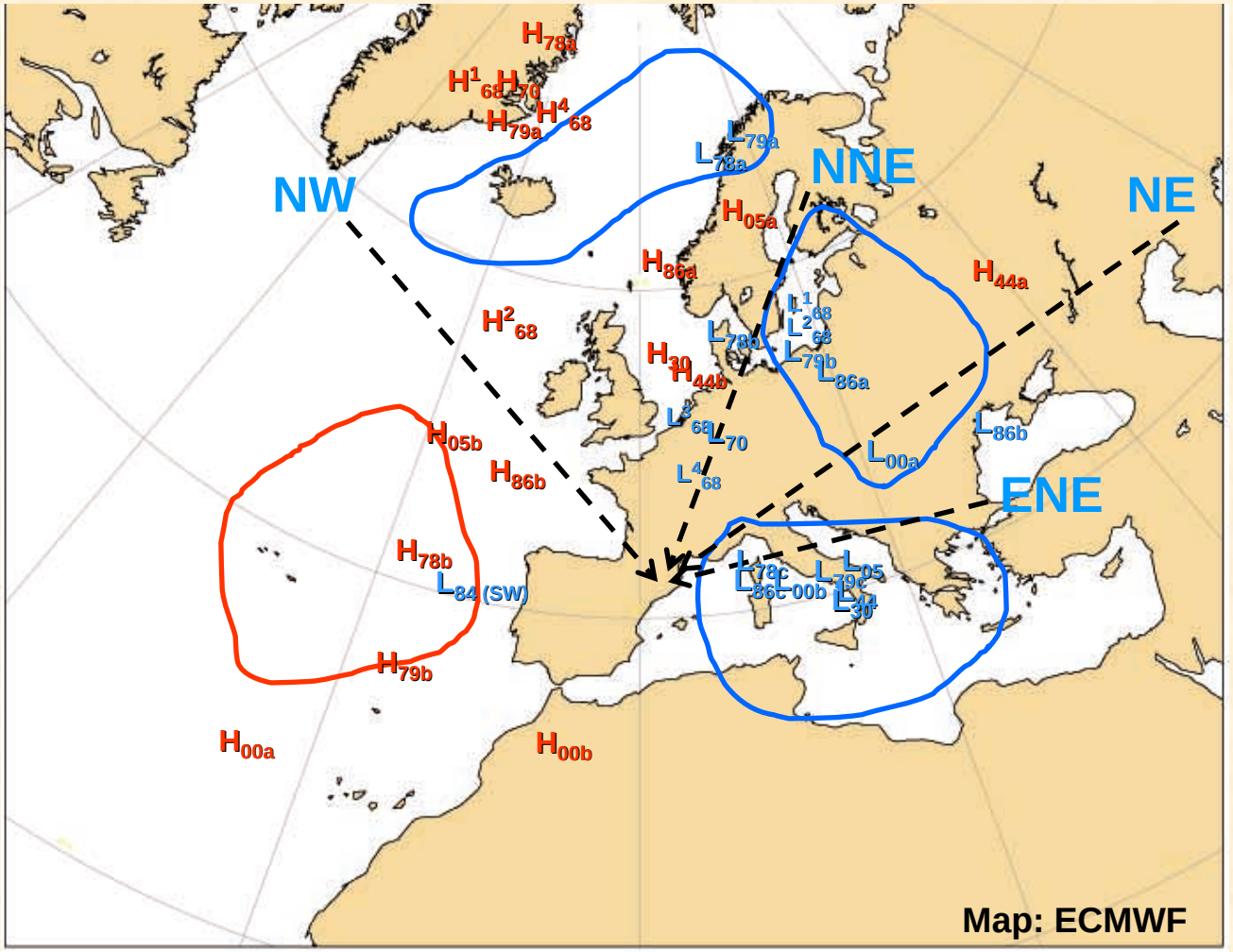
Climatic context (8)

L and H centers location (SL). Northerly flow. 30 years.



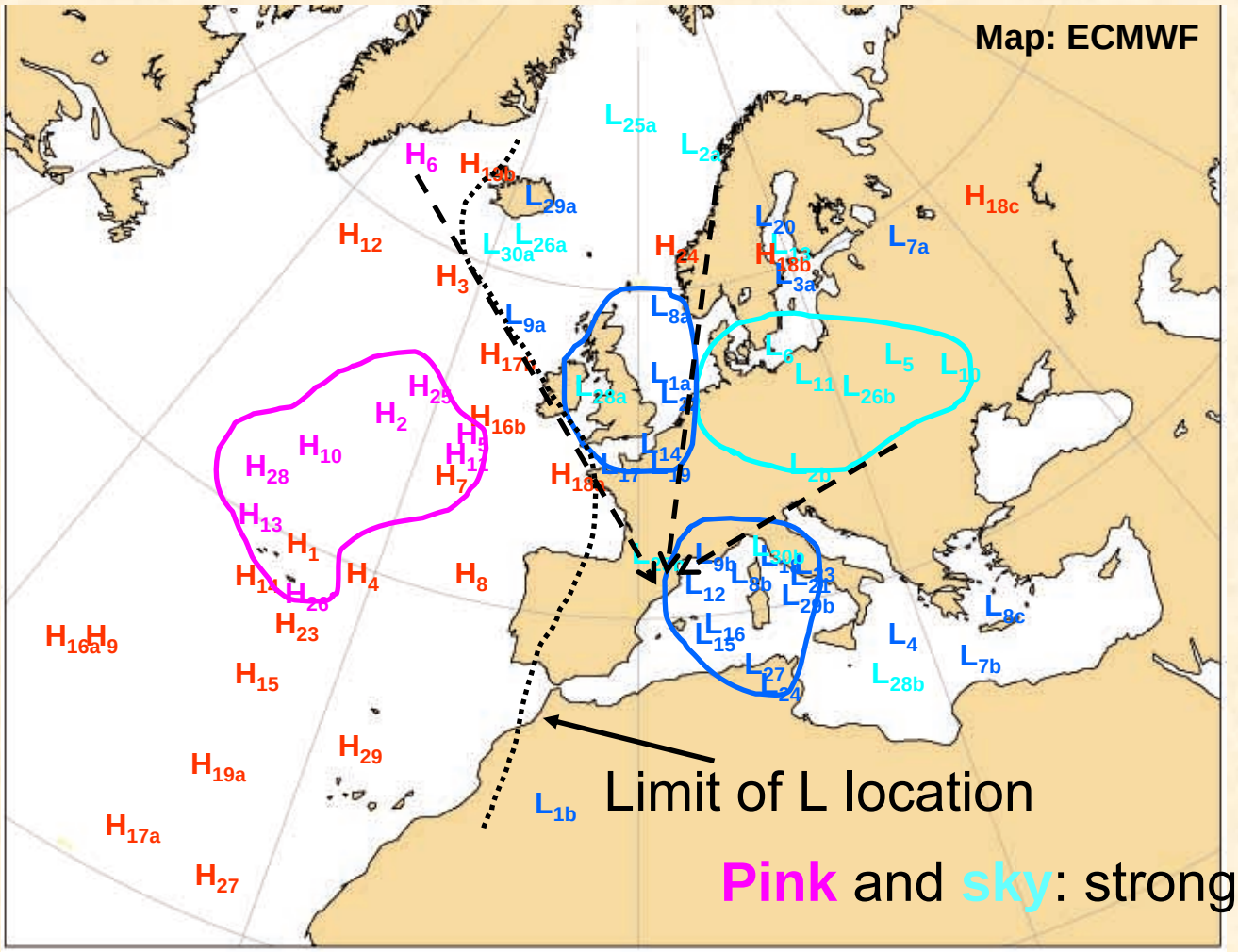
Climatic context (9)

L and H centers location (SL). Events.



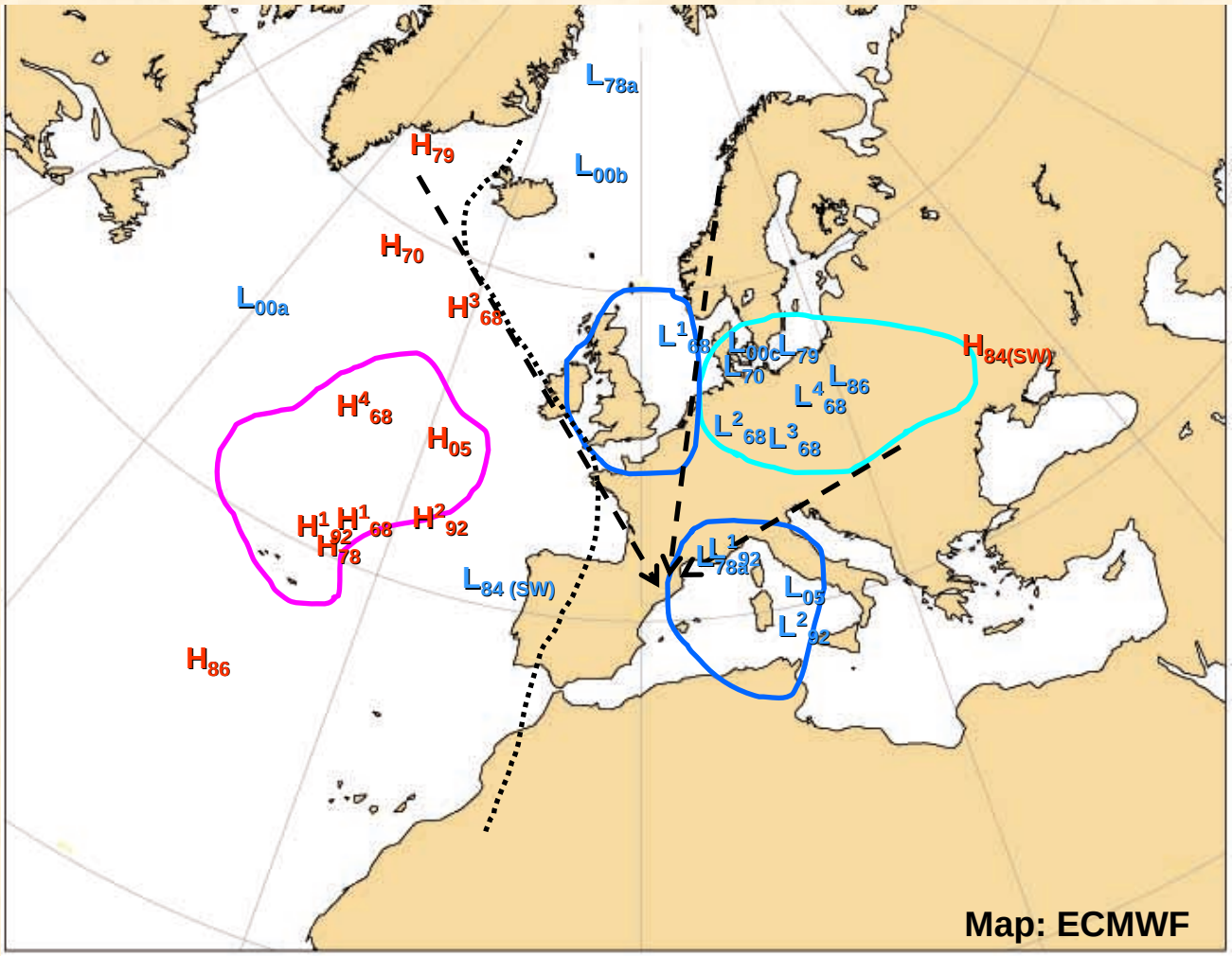
Climatic context (10)

L and H centers location (500 hPa). Northerly flow. 30 years.



Climatic context (11)

Low and high centers location (500). Events.



Mitigation measures

Knowledge of geographical features, accidents characteristics and climatological aspects suggests some mitigation measures to risk reduction:

- More accurate local forecasts and warnings for Mediterranean Pyrenees when northerly synoptic flow it is forecasted.
- Forecasts and warnings should be easy accessible at mountain resorts, tourism offices, etc.
- Local forecasts and warnings should contain explanations about expected environmental conditions as a whole, not only atmospheric elements.
- Education should be improved about mountain meteorology, specifically for mountaineers and visitors to risk areas.
- It should be stressed that environmental conditions can change very rapidly and rise to very dangerous levels.

Thank you for your attention

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